M LIBRARY JUL 13 1948

1948, No. 2 JUNE 30

COPEIA

Established in 1913

PUBLISHED BY
THE AMERICAN SOCIETY OF ICHTHYOLOGISTS
AND HERPETOLOGISTS

Copeia *1948, No. 2* *June 30*

CONTENTS

STATUS, RELATIONSHIPS, AND CHARACTERS OF THE PERCID FISH, *Poecilichthys sagitta* JORDAN AND SWAIN. By *Reeve M. Bailey* 77

THE RANGE AND CHARACTERS OF *Synchirus gilli*, A REMARKABLE COTTID FISH OF THE NORTHEASTERN PACIFIC. By *Robert R. Miller* and *Donald S. Erdman* 85

OBSERVATIONS ON THE HABITS AND EARLY LIFE HISTORY OF THE BATRACHOID FISH, *Porichthys notatus* GIRARD. By *Harbans Lall Arora* 89

THE USE OF ROTENONE FOR COLLECTING REEF AND LAGOON FISHES AT BIKINI. By *Leonard P. Schultz* 94

COMPARISON OF CALCULATED FISH LENGTHS BASED ON SCALES FROM DIFFERENT BODY AREAS OF THE SARDINE, *Sardinops caerulea*. By *J. B. Phillips* 99

TWO NEW SUBSPECIES OF THE SALAMANDER, *Plethodon shermani*. By *Clifford H. Pope* and *Nelson G. Hairston* 106

SEXUAL MATURITY IN THE MALE TURTLE, *Pseudemys scripta troostii*. By *Fred R. Cagle* 108

A NEW *Liolaemus* FROM PARAGUAY. By *Benjamin Shreve* 111

THE RELATIONSHIPS OF THE GARTER SNAKE *Thamnophis ordinoides*. By *Wade Fox* 113

FURTHER REMARKS CONCERNING *Thamnophis ordinoides* AND ITS RELATIVES. By *Henry S. Fitch* 121

MARKING REPTILES WITH AN ELECTRIC TATTOOING OUTFIT. By *Angus M. Woodbury* 127

HERPETOLOGICAL NOTES—Eggs of *Desmognathus aeneus*, by *Walter C. Brown* and *Sherman C. Bishop*; 129.—Notes on a Large Specimen of *Phrynosoma solare* Gray, by *Richard A. Edgrén, Jr.*: 129.—Notes on the Breeding Habits of the Turtle *Kinosternon s. subrubrum*, by *Frederick M. Barkalow, Jr.*: 130.—Odor of Young Box Turtles, by *Wilfred T. Neill*: 130.—Northward Occurrence of the Canyon Tree toad in California, by *George W. Salt* and *Robert C. Stebbins*: 131.—Notes on a Litter of Young Timber Rattlesnakes, by *Richard A. Edgren, Jr.*: 132.—Note on the Three-toed Box Turtle, by *A. S. Lockley*: 132.—*Farancia abacura reinwardtii* in Oklahoma, by *W. Leslie Burger, Jr.*: 133.—*Storeria occipitomaculata* in Northwestern Ohio, by *Charles A. Triplehorn*: 133.—Salamanders of the Genus *Pseudotriton* from Georgia and South Carolina, by *Wilfred T. Neill*: 134.—Records of Amphibians and of the Northern Alligator Lizard in Northwestern California, by *Vinson Brown*: 136.—The Incidence of Poisonous Snakes on Okinawa Shima (Ryukyu Islands), by *James A. Slater*: 136.—Emergence of *Coluber c. constrictor* from Hibernation, by *Elias Cohen*: 137.—Diamond-back Terrapin in Connecticut, by *Leo Charles Finneran*: 138.—An Iowa Record of the Keeled Green Snake, by *W. D. Klimstra*: 138.—Extra-uterine Embryos in Snakes, by *Wilfred T. Neill*: 139.—More Records of Reptiles from Portage County, Ohio, by *Ralph W. Dexter*: 139.

ICHTHYOLOGICAL NOTES—Two Additions to the Known Fish Fauna of California, by *John C. Marr*: 140.—The Intestinal Convolutions: New Generic Characters for the Separation of *Carpiodes* and *Ictiobus*, by *Lester M. Berner*: 140.—Notes on Some Gulf of Maine Fishes, by *Leslie W. Scattergood*: 142.—The Mosquitofish, *Gambusia*, Established in the Great Lakes Region, by *Louis A. Krumholz*: 144.—New Records for the Fish, *Myrichthys tigrinus*, a Snake Eel of the Eastern Tropical Pacific, with a Relocation of the Type Locality, by *Robert Rees Harry*: 145.—Color Notes on Pacific Manta, Including a New Form, by *Otis Barton*: 146.

REVIEWS AND COMMENTS—Vie et Moeurs des Amphibiens Grenouilles, Crapauds, Tritons, Salamandres, Cecilies: Fernand Angel, by *Karl P. Schmidt*: 148.—The World's Great Lakes: Ferdinand C. Lane, by *Ralph Hile*: 148.—La Vie des Cameleons et autres Lezards: Fernand Angel, by *Karl P. Schmidt*: 149.—Aus dem Tierleben der Tropen Reisebilder aus Asien, Afrika und America: Robert Mertens, by *Karl P. Schmidt*: 149.—The Book Of Trout Lore: John Crowe, by *Albert S. Hazzard*: 150.—Fishes of the Great Lakes Region: Carl L. Hubbs and Karl F. Lagler, by *George S. Myers*: 150.—The Ways of Fishes: Leonard P. Schultz (with Edith M. Stern), by *Gerald P. Cooper*: 151.

EDITORIAL NOTES AND NEWS—Lerner Marine Laboratory: 151.—Norman's History of Fishes: 151.—News Notes: 152.

Published quarterly by the American Society of Ichthyologists and Herpetologists, at the Museum of Zoology, University of Michigan, Ann Arbor, Michigan, under the Act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized February 11, 1924. Printed by Ann Arbor Press, Ann Arbor, Michigan.

Status, Relationships, and Characters of the Percid Fish, *Poecilichthys sagitta* Jordan and Swain

By Reeve M. Bailey

On one of his famous walking trips, David Starr Jordan and his party stopped briefly to collect fishes in Wolf Creek and other tributaries of the Clear Fork of the Cumberland River near Pleasant View, Whitley County, Kentucky. From the fishes taken, Jordan and Swain (1883) described *Poecilichthys sagitta* on the basis of a single specimen which has remained the only known example until the present time. In the original description they noted that there was but a single anal spine, an unusual condition, since all species of *Poecilichthys* normally have two anal spines. They expressed the opinion that the unique individual was probably abnormal in this respect. Subsequently, however, Jordan and Evermann (1896: 1066, 1068, and 1080) apparently regarded the presence of a single spine as of marked significance since they erected the subgenus *Torrentaria* for the reception of *sagitta* and a Mexican fish, *Etheostoma australe* Jordan, which also has one anal spine. Jordan, Evermann, and Clark (1930: 293) elevated *Torrentaria* to generic rank, and included the same two species. Recently Hubbs (1936) noted that *Torrentaria* Jordan and Evermann is preoccupied and proposed the substitute name *Austroperca* for the Mexican species only. He regarded as uncertain the status and relationships of *sagitta*.

Recently the Museum of Zoology has secured four lots (comprising 24 specimens) of *sagitta* including some taken near the type locality.

Despite the reported occurrence of a single anal spine in the type, *sagitta* does not differ from the other species of *Poecilichthys* in this character since each of the 22 specimens examined has two anal spines; if counted correctly the type is atypical.

No intimately related species are revealed by a comparison of *sagitta* with the species referred to *Poecilichthys* (*sensu latu*) by current authors, including the genera *Poecilichthys, Nanostoma, Nothonotus, Rafinesquiellus, Oligocephalus, Nivicola, Claricola, Catonotus, Torrentaria* (in part), and *Boleichthys* (in part) of Jordan, Evermann, and Clark, 1930. However, two species, *nianguae* and *spilotus,* heretofore referred to the genus *Hypohomus,* agree with *sagitta* in many characters. Those forms are regarded as incorrectly assigned to *Hypohomus* (Table I), and their inclusion in *Poecilichthys* seems proper. Within the genus *Poecilichthys* these species plus *sagitta* almost certainly constitute a compact natural group, here regarded as a subgenus. To erect a genus for these species would only add to the already overburdened complexities of generic classification in the Etheostomatinae.

The three species (*nianguae, spilotus,* and *sagitta*) agree with *Poecilichthys* in that the premaxillae are nonprotractile; the belly is covered with unspecialized scales of normal size; there are no enlarged modified scales on the breast or between the pelvic fin bases; there is no semicircular flange-like ridge on the lower side of the caudal peduncle; the anal fin, though rather long, has a smaller area than the soft dorsal; the pelvic fins are separated by a space not greater than two-thirds the fin base; the lateral line is

2b.—Head less slender, with dorsal contour gently convex. Distance from origin of dorsal to occiput contained 1.4 to 1.9 (usually 1.6 or more) times in distance from occiput to tip of snout. Branchiostegal rays most often 6 (7 on one side of one of the 9 specimens examined). Scale rows around caudal peduncle 22 to 24 (22 in only one of 15 specimens counted). *Tributaries of the Upper Cumberland River, Kentucky.*

Arrow darter, *Poecilichthys sagitta*

In the preparation of the above key I have been privileged to study specimens of *P. nianguae* recently collected by George V. Harry in the course of his distributional study of Missouri fishes. Dr. Robert R. Miller has kindly loaned me, from the collection of the United States National Museum, two specimens of *P. spilotus,* Nos. 63778 and 125360, collected by A. J. Woolman in Redbird Creek, 1 mile west of Big Creek, and in Hector Creek, 5 miles west of Big Creek, Kentucky (reported by Woolman, 1892: 280, fig. 3). Mr. Minor Clark, Kentucky Division of Fish and Game, has donated specimens and has furnished information on the distribution of *P. sagitta.* I am indebted also to Dr. Carl L. Hubbs who has read the manuscript and offered suggestions.

Poecilichthys sagitta Jordan and Swain

(Plate I, figs. 1–2)

Poecilichthys sagitta.—Jordan and Swain, 1883: 250–251 (original description; Wolf Creek near Pleasant View, Whitley County, Kentucky).

Etheostoma sagitta.—Woolman, 1892: (268 reference to Jordan and Swain). Boulenger, 1895: 67, 88 (characters; after Jordan and Swain). Jordan and Evermann, 1896: 1068, 1080–1081 (original description repeated with minor changes). Evermann, 1918: 359, 368 (references). Hubbs, 1936: 1–2 (status and relationship of species uncertain).

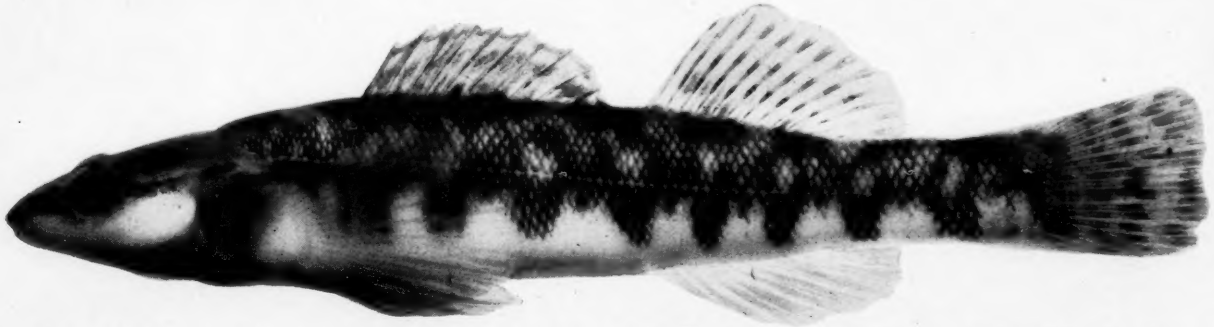
Torrentaria sagitta.—Jordan, 1929: 168–169 (compiled). Jordan, Evermann, and Clark, 1930: 293 (listed). Schrenkeisen, 1938: 234 (compiled).

Except in the anal spine count (see p. 77) and in the development of the lateral line, the new specimens agree well with the original description of *sagitta,* which is an accurate characterization of the species. Jordan and Swain reported 68 scales, of which 48 had tubes [20 without pores]; in 15 specimens I count from 58 to 69 scales, of which 49 to 65 are pored and only 2 to 13 lack pores.

New Material.—*P. sagitta* is apparently confined in its distribution to the Upper Cumberland River System. The localities reported below are from this drainage and all collections were taken in Kentucky during 1947. UMMZ No. 144492, 14 half-grown and adult specimens from 35.0 to 56.6 mm. in standard length, collected in Little Wolf Cr., a short distance above its confluence with Wolf Cr. (tributary to Clear Fork), 2.5 mi. west of Pleasant View, Whitley Co., on April 8, by Reeve M. Bailey and Norman J. Wilimovsky. UMMZ No. 144424, one adult and 2 young, 21.0 to 54.6 mm. in length, collected in Watts Cr., 1.5 mi. above Williamsburg, Whitley Co., on June 15, by Wm. Ralph Taylor and Max Proffitt. UMMZ No. 144691, 5 young and adult, 47.5 to 75.0 mm. in length, collected in Bunches Cr., ¼ mi. above mouth (at Highway 92, 6 mi. above Williamsburg), Whitley Co.,

UNIV. OF MICH.

Fig. 1. *Poecilichthys sagitta,* an adult prespawning male, 56.6 mm. in standard length (UMMZ No. 144492). The breeding tubercles can be seen on the belly between the tip of the pelvic fin and the anus.



Reeve M. Bailey

Fig. 2. *Poecilichthys sagitta,* an immature male, 47.0 mm. in length (UMMZ No. 144492), showing the characteristic color pattern of females and immature fish. Photographs by Clarence M. Flaten.

Oct. 19, by Minor Clark and Leonard Joeris. UMMZ No. 144692, 2 adults, 76.5 and 81.0 mm. in length, collected in Brownies Cr. at mouth of Crubbage Cr. (reached from highway 119, 15 mi. above Pineville on the Oakes, Kentucky, road), Bell Co., on Oct. 7, by Joeris.

Mr. Minor Clark reports additional specimens taken at the following localities:

Parsons Branch and Bad Br. (½ mi. apart), about 5 mi. from Highway 119 on the Eolia Road, Letcher Co., Oct. 28; Clark and Joeris. Childs Cr., at Junction of Clover Fork of Cumberland R., 2 mi. above Closplint, Harlan Co., Oct. 14; Joeris. Pleasant Run Cr., near Williamsburg, Whitley Co., Oct. 3; Clark and Joeris.

TABLE II

PROPORTIONAL MEASUREMENTS (EXPRESSED IN THOUSANDTHS OF THE STANDARD LENGTH) OF TEN SPECIMENS OF *Poecilichthys sagitta*. The largest specimen of each sex is from UMMZ No. 144692; all others are from UMMZ No. 144492.

Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Maturity	Ad.	Ad.	Ad.	Im.	Im.	Ad.	Ad.	Ad.	Ad.	Ad.
Standard length (mm.)	76.5	56.6	51.7	46.6	41.2	81.0	45.8	44.9	43.2	38.4
Proportions of standard length:										
Head length	305	316	300	300	313	288	306	303	319	315
Greatest depth	191	196	186	187	177	183	214	214	225	205
Least depth	116	106	97	101	97	107	103	100	101	102
Body width	150	129	128	131	131	143	162	163	164	154
Caudal peduncle length	204	194	219	212	218	199	212	214	213	214
Highest dorsal spine	118	122	126	105	109	104	98	100	95	112
Highest dorsal soft ray	176	173	164	152	160	154	144	149	148	151
Caudal length	192	187	197	193	204	179	201	194	194	214
First anal spine	52	58	58	45	56	44	52	38	42	49
Highest anal ray	153	150	147	142	146	142	142	149	144	143
Longest pectoral ray	227	228	236	236	235	216	236	236	238	245
Pelvic length	214	210	205	206	199	179	212	198	190	221
Pelvic base	41	35	41	41	39	38	39	40	39	36
Interpelvic distance	21	21	21	21	22	21	22	22	23	21
Head depth	158	150	141	139	143	143	153	145	160	151
Head width	159	163	137	131	143	152	148	136	157	130
Snout length	68	71	66	64	70	64	68	67	72	73
Orbit length	55	60	64	67	70	49	68	67	67	70
Fleshy interorbital width	46	44	44	41	41	40	41	42	44	39
Upper jaw length	92	87	87	88	85	89	87	89	90	96
Distance from tip of jaw to union of gill membranes	153	143	147	161	170	154	157	156	169	172
Distance from union of gill membranes to insertion of pelvic fin	152	175	155	142	150	151	153	158	160	151

ADDITIONAL CHARACTERS.—Many of the characters of *sagitta* are expressed as proportional measurements (Table II) or may be seen in the photographs (Pl. I) painstakingly made by Clarence M. Flaten.

Scale row and fin ray counts were taken on 15 specimens from Little Wolf Creek and Watts Creek. From the origin of the second dorsal to the lateral line the scale rows number 8 (11 specimens) or 9 (4); those from the origin of the anal to the lateral line, 11 (6) or 12 (9); and those around the caudal peduncle, 22 (1), 23 (9), or 24 (5). The counts of transverse scale rows on the body are 58 (1), 60 (2), 61 (3), 63 (2), 66 (1), 67 (1), and

69 (1). The pored scales number 49 (2), 51 (1), 52 (1), 53 (2), 54 (1), 57 (3), 58 (1), 59 (2), 60 (1), and 65 (1). The unpored scales number 2 (1), 4 (2), 5 (2), 6 (2), 7 (3), 9 (1), 10 (2), 12 (1), and 13 (1). The dorsal spines number 9 (1), 10 (13), and 11 (1); dorsal soft rays (last counted as double at the base), 12 (1), 13 (2), 14 (10), and 15 (2); caudal rays (branched rays plus 2), 17 (15); anal spines, 2 (15); anal soft rays (last counted as double at the base), 9 (1), 10 (5), 11 (8), and 12 (1); and the pectoral rays, 14—14 (2), 14—15 (2), and 15—15 (11). The branchiostegal rays number 6—6 (8) or 6—7 (1) in 9 specimens.

The cephalic canals of the lateral line system are of the generalized percid type. In the 15 specimens examined there are uniformly 5 lateral pores, a single postorbital pore on each side, a single coronal pore, and one interorbital, one posterior nasal, and one anterior nasal pore on each side. The supratemporal commissure has 3 pores and is complete in 14 specimens, has 4 pores and is narrowly interrupted at the middle in one. The infraorbital canal is complete, with 8 pores in 13 specimens and 9 pores in 2. The operculomandibular canal has 9 (1), 10 (13), or 11 (1) pores.

The vertebrae, counted on Roentgen-ray photographs of 14 specimens, number, including the urostylar vertebra, 39 in 7 and 40 in 7.

The rather heavily pigmented genital papilla of the adult male is a low conical flap with a broad base and a bluntly pointed tip. The immaculate papilla of the pre-spawning female is a much exerted, rather heavy cone with a large terminal aperture.

Breeding Tubercles.—The presence of breeding tubercles on nuptial males of *sagitta* is notable since these structures have not previously been described in any species of *Poecilichthys*. The only tubercles that have been noted for any darters are those on the lower fins of a few species, including *Hadropterus evides* and the several species of *Imostoma*. No fin tubercles are apparent in *sagitta*, but the two pre-spawning males taken on April 8 in Little Wolf Creek have well-developed tubercles on the ventral surface of the body. In this region a single tubercle is developed on the mid-line of each scale just anterior to its posterior margin. The tubercles occur on the posterior half of the belly, extending up about 6 scale rows on the side; on 2 rows on either side of the base of the anal fin; and on 6 or 7 rows of scales on the lower edge of the caudal peduncle. Most of the tubercles are low and rounded, but those near the midventral line anterior to the vent and on the caudal peduncle are bluntly conical. The tubercles are pale, not contrasting with the ground color. Structurally, the nuptial tubercles are superficial excrescences, like the pearl organs of cyprinid fishes. They are not to be confused with the perhaps analogous, spinous projections (enlarged ctenii) on the midventral scales in *Hadropterus* and certain other genera. It seems probable that the tubercles and the ctenii function in the nuptial embrace. No tubercles are developed in females.

Coloration.—Like most species of *Poecilichthys, sagitta* in nuptial colors is a gorgeous little creature. Life colors, of specimens collected in Little Wolf Creek shortly before spawning, were recorded as follows: In adult males the dull olive green of the anterior parts shades to dull blackish-green in bands on the caudal peduncle (Pl. I, Fig. 1). The sides are adorned with

from 8 to 11 narrow vertical bars, which are dark orange-red and are bordered with light. The bars are most conspicuous on the caudal peduncle, where they are narrow and high. At their lower ends the bars are fused to form a longitudinal ventrolateral bar of orange-brown. The belly is dirty white and the breast dusky. Red-orange spots are scattered over the upper sides. Dull olive green above, the head is brightened on the lower surface by the iridescent purple of the mandibles and by the white of the branchiostegal membranes. The blackish scapular bar is inconspicuous. A narrow golden rim borders the pupil.

A narrow submarginal band of bright red-orange in the spinous dorsal fin is separated by a narrow clear area from the bright green bar which covers the median half of the fin. The basal fourth is white, shot with dusky. Small red-orange spots are irregularly aligned in three rows on the dusky second dorsal fin. The green on the basal part of the caudal is best developed on the lower lobe of the fin, where it covers one-fourth of the rays; otherwise the caudal is faintly olive-dusky, with two or three irregular vertical red-orange bars or series of spots on the distal two-thirds of the fin. The basal two-thirds of the anal fin is green; the outer third, dirty white. The immaculate pectoral fins are washed with dull olive and the pelvic fins are dusky.

Immature males (Pl. 1, Fig. 2) and mature females are alike in coloration. The straw-color of the anterior parts of the body grades to dark olive on the peduncle. The lateral blotches, unlike those of breeding males, are not uniformly dark, but are either V-shaped or quadrate and bear dorsally a light spot that is either enclosed or is in contact with the ground color above. The vertical bars on the body and caudal peduncle are less well developed than in adult males and are orange rather than deep red-orange. Dull yellowish-gold covers the lower sides. Except for a narrow submarginal band of red-orange, the spinous dorsal is whitish. A few faint orange spots relieve the white of the second dorsal fin and the caudal is dusky, with weak orange bars. The anal and pelvic fins are clear white. The pectorals are pale, washed with olive. From the chin to behind the anal fin the lower surface is clear white. The cheeks are shining white, more conspicuously so than in the adult male.

RELATIONSHIPS.—As indicated above the only species closely related to *sagitta* are *P. nianguae* (Gilbert and Meek) and *P. spilotus* (Gilbert). Since each has a restricted range in hilly or mountainous upland streams, the three species may be regarded as relicts, each of which, with isolation, has differentiated *in situ* from a more wide-ranging ancestral stock. This group of species re-emphasizes the alliance of the Ozarkian and Appalachian upland fish faunas, which share most genera but harbor many different species and subspecies. As judged by morphological similarity, *P. spilotus* and *P. sagitta,* the two eastern species, are more closely related to one another than either is to *P. nianguae.* Their geographic ranges are closely approximated, but are separated by the divide between the Cumberland and Kentucky river watersheds. It is not improbable that this divide was crossed by an ancestral stock, probably from the Cumberland system into the Kentucky. The region should be searched for evidence of a stream capture.

HABITAT AND HABITS.—At the collection site, Little Wolf Creek was a

pool and riffle stream 10 to 15 feet in width and as deep as two feet. It flowed over a bottom of bedrock, gravel, and rubble. The water was murky from recent rains.

In this habitat *P. sagitta* was living under rather large flat stones on the deepest and swiftest riffles. In association with *sagitta*, the commonest larger animals were crayfish and salamanders (*Eurycea b. bislineata*). *Poecilichthys kennicotti cumberlandicus*, the commonest darter in the stream, also inhabited riffles but was taken in weaker current and from under coarse gravel and small stones. *Boleosoma nigrum susanae* was uncommon and lived in the pools.

When collected on April 8 (morning water temperature 49°F.) *sagitta* had not yet spawned, but the adult females were bulging with eggs. The length of the young specimens (21.0 and 21.5 mm.) taken in Watts Creek on June 15 indicates that spawning probably occurred in April.

Summary

On the basis of newly collected material *Poecilichthys sagitta* Jordan and Swain, from the Upper Cumberland River system, is referred to *Poecilichthys*. The type was aberrant in having a single anal spine. Two species currently referred to *Hypohomus*, namely *nianguae* from the Ozark Upland and *spilotus* from the Kentucky River basin, are the only species that are intimately related to *P. sagitta*. These two darters are therefore transferred to *Poecilichthys*, and the new subgenus *Litocara* is proposed for the three species, with *P. sagitta* as type. These species are sharply differentiated (see key on pp. 79-80) and appear to be relicts of a wide-ranging common ancestor. Among the characters reported for *P. sagitta*, the breeding tubercles on the ventral scales of adult males is particularly noteworthy. Such scale structures have not previously been described for any darter.

Literature Cited

Boulenger, George Albert
1895 Catalogue of the Perciform fishes in the British Museum. Cat. Fishes Brit. Mus. (2nd ed.), 1: i-xix, 1-394, pls. 1-15, figs. 1-27.

Evermann, Barton Warren
1918 The fishes of Kentucky and Tennessee: a distributional catalogue of the known species. *Bull. U.S. Bur. Fish.*, 35 (1915-16): 293-368.

Hubbs, Carl L.
1936 *Austroperca*, a new name to replace *Torrentaria*, for a genus of Mexican fishes. *Occ. Pap. Mus. Zool., Univ. Mich.*, 341: 1-3.

Jordan, David Starr
1929 Manual of the vertebrate animals of the Northeastern United States inclusive of marine species. 13th ed.; Yonkers-on-Hudson: i-xxxi, 1-446, 15 figs., 1 map.

Jordan, David Starr, and Barton Warren Evermann
1896 The fishes of North and Middle America. . . . Part 1. *Bull. U.S. Nat. Mus.*, 47 (1): i-lx, 1-1240.

Jordan, David Starr, Barton Warren Evermann, and Howard Walton Clark
1930 Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Colombia. *Rept. U.S. Comm. Fish.*, 1928 (2): 1-670.

JORDAN, DAVID S., and JOSEPH SWAIN
1883 List of fishes collected in the Clear Fork of the Cumberland, Whitley County, Kentucky, with descriptions of three new species. *Proc. U.S. Nat. Mus.*, 6: 248–251.

SCHRENKEISEN, RAY
1938 Field book of fresh-water fishes of North America north of Mexico. G. P. Putnam's Sons, New York: i–xii, 1–312, many figs.

WOOLMAN, ALBERT J.
1892 Report of an examination of the rivers of Kentucky, with lists of the fishes obtained. *Bull. U.S. Fish Comm.*, 10 (1890): 249–288, pl. 51.

MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN.

The Range and Characters of *Synchirus gilli*, A Remarkable Cottid Fish of the Northeastern Pacific [1]

By ROBERT R. MILLER and DONALD S. ERDMAN

IN 1890, Tarleton H. Bean described a cottid fish which possesses such remarkable characters that a new subfamily, the Synchirinae, was erected for its sole reception. In recent classifications of the cottid fishes, Jordan (1923) and Taranetz (1941) raised this group to family rank. *Synchirus gilli* is at once distinguished from all other members of the varied family Cottidae by the anterior and ventral fusion of the pectoral fins to form a cup-like structure. This organ, used along with the specialized, recurved tips of the pelvic fins, enables *Synchirus* to cling to sea lettuce (*Ulva*), sea anemones, and barnacles on wharf piles and rocks (Evermann and Goldsborough, 1907: 325; Chapman and DeLacy, 1933: 102; Clemens and Wilby, 1946: 266). This curious fish is further characterized by the remarkably long pubic bones and the consequent posterior position of the I,3 pelvics and by the highly specialized genital papilla of the male, which retracts into a deep pit before the anal fin. Otherwise the appearance of *Synchirus* is much like that of the genus *Triglops*.

Originally described from Barclay (=Barkley) Sound, British Columbia, the species has since been recorded from a few other localities in that general region (Schultz and DeLacy, 1936: 132; Clemens and Wilby, 1946: 266). In their recent account of the fishes of the Pacific Coast of Canada, Clemens and Wilby (*loc. cit.*) gave the range of *S. gilli* as Puget Sound to Vancouver Island. The known range of the manacled sculpin is now extended northward to Sitka, in the Alexander Archipelago of southeastern Alaska, by the discovery of 4 specimens in the U. S. National Museum (No. 134907) taken by the *Albatross* in August, 1892.

The rarity of preserved specimens of this interesting fish and the slight inaccuracies in its published descriptions have prompted us to describe certain features exhibited by the 19 specimens now deposited in the National Museum, and to figure one of the cotypes. In enumerating the number of soft dorsal and anal rays, we have conformed to usual practice by students of marine cottids and counted each ray as a separate element. All rays of

[1] Published by permission of the Secretary, Smithsonian Institution.

both pectoral fins were counted. The pelvic rays invariably number I,3 on both sides. The lateral pores were counted on the left side of the body.

These data and the specimens agree with the excellent original description by Bean (1890) with two notable exceptions. He and others have overlooked the first dorsal spine, which is only narrowly separated from the second but is readily seen by using indirect lighting and good magnification. That Bean also failed to see the generally minute cirri is not surprising, since they require very close examination under bright light and even then may escape notice. Clemens and Wilby first described the postocular cirri, but the preopercular and nasal cirri seem to have been missed heretofore. All these cirri are variably present or absent on the 19 specimens examined, but this material is generally so old and in such poor condition that we believe these delicate structures have been largely broken off on those individuals that do not now possess a full complement. The usual condition appears to be as follows: (1) three preopercular cirri on each side of the head, lying about midway between the 4 preopercular pores along the margin of the preopercle and anterior to the base of the bifid preopercular spine; this number was increased to 4 on either the left or right side on 3 of the 15 specimens examined that had preopercular cirri; (2) a single postocular cirrus on each side, varying somewhat in length but generally minute; on the left side of one specimen (USNM No. 60542, see Table I), 2 cirri, possibly representing a single, bifid cirrus, were found; (3) a single nasal cirrus adjacent to each nasal spine, varying from short to almost filamentous.

The caudal fin rays of most of the specimens were too badly broken to enable an accurate count. The basic number seems to be 7 branched, making a total of 9 principal rays, but the bifurcation of the caudal rays is not always clear-cut.

A variation of 39 to 42 lateral pores was noted. The number of spinose scales is generally 1 or 2 fewer as these scales become weak anteriorly and usually disappear entirely at the beginning, as well as at the end, of the lateral line. The spinose scales on each side, parallel to and near the base of the soft dorsal fin, are variable in number on the material examined; but again this seems due, in part at least, to the ease with which these structures may be knocked off in handling. These scales are widely spaced and are represented as single scales, or are arranged in closely associated groups of 2 to 3 or more extending obliquely backward and downward from near the base of the second dorsal. On one female cotype (USNM No. 41820), the scales extended posteriorly onto the caudal peduncle, but in all other specimens they did not reach much beyond two-thirds of the length of the base of the second dorsal fin. The first of these scales lies opposite or very slightly in advance of the origin of this fin.

The short preopercular spine is invariably widely bifid and strongly developed, and the two nasal spines are stout and pointed. The branchiostegals numbered 6 on each side, except for one specimen (the single female cotype) which had 7 on the left side. Vomerine teeth were invariably present and were well developed as an oval or crescentic patch. Palatine teeth, however, were variable but generally were weakly developed or absent.

In their paper on the fishes of Alaska, Evermann and Goldsborough (*loc.*

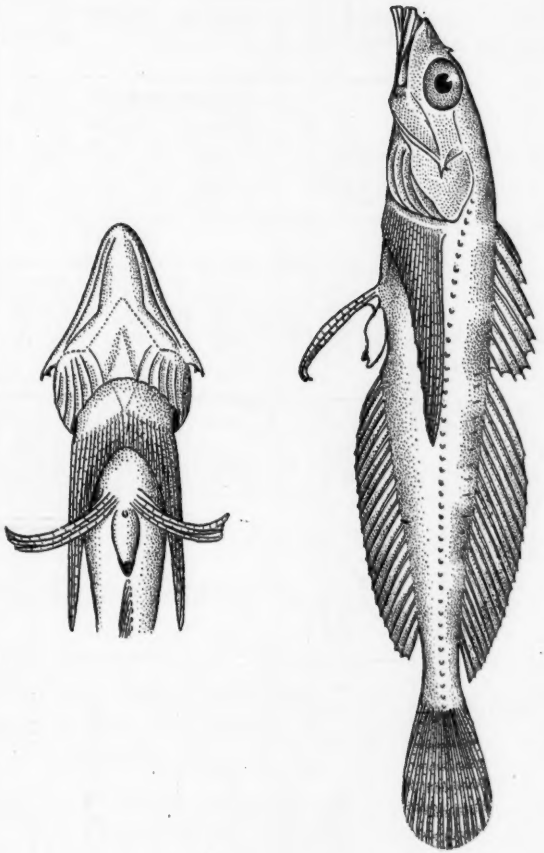


PLATE I

Male cotype (USNM No. 41820), 36 mm. in standard length, of *Synchirus gilli*, based on an original drawing made in 1890. Retouched by Mrs. Aime M. Awl.

TABLE I

COUNTS RECORDED FOR 19 SPECIMENS OF *Synchirus gilli*

USNM Cat. No. and Locality	60542 Port Townsend, Washington	104525 False Bay, Washington	41820 Cotypes Barkley Sound, B.C.	45365 Barkley Sound, B.C.	127045 Barkley Sound, B.C.	134907 Sitka, Alaska
No. of Specimens	1	1	4*	7	2	4
Characters:						
Dorsal spines	X	X	IX, X, X, X	IX–X	IX, X	IX, X, X, X
Dorsal rays	20	20	20, 20, 21, 21	20 (4), 21 (3)	20, 21	19, 20, 20, 20
Anal rays	20	20	20	20 (6), 21 (1)	19, 20	19, 19, 20, 20
Pectoral rays	22	21 or 22	22–23	22–24	22–23	21–22
Caudal rays						
Branched	7	8 or 9?	7, 7	7	7	.....
Total	27	26?	27, 27, 28, 28	27–31	27, 29	26, 27, 28, 29
Lateral pores	40	39 or 40	40, 40, 41, 42	39 (1), 40 (3), 41 (2)	40, 41	39, 39, 39, 40
Oblique scale rows along each side of dorsal	Trace	Absent	2–19	0–15	14–18	0–14
Dermal cirri†						
Preopercular	1–2	Absent?	2–1, 3–3	2–3, 3–3, 3–4, 4–3	3–3, 3–4	1–1, 2–3, 3–3
Postocular	2–1	Absent?	0–1	0–1, 1–1	0–1, 1–0	0–1, 1–1
Nasal	1–1	Absent?	1–0, 1–1	1–1	1–1	1–1

* Although only 3 were recorded by Bean, there are now 4 specimens in the type jar. The fourth was presumably added to the jar subsequently but it is not distinguishable from the others by the original description. Clemens and Wilby (1946: 266) erroneously stated that Bean selected and recorded one specimen as the type. That he probably intended to select a type is indicated by the original drawing (Pl. 1) as it bears the identification "*Synchirus gilli* Bean (type)."

† In enumerating the dermal cirri, the variation in counts for both sides is recorded: the count for the left side is given first.

cit.) made several erroneous statements in their short description of *S. gilli*. A re-examination of their specimen (USNM No. 60542, see Table I) shows X (rather than IX) dorsal spines, the normal series of ctenoid scales along the lateral line, as well as a trace of these structures along the right side of the second dorsal fin.

An examination of Table I shows that there is a slight but unmistakable trend for reduction in the number of dorsal, anal, and pectoral rays and lateral pores in the Alaskan sample. Whether this may represent a racial or an individual variation, or both, cannot be determined from the small series studied.

Literature Cited

Bean, Tarleton H.
1890 Description of a new cottoid fish from British Columbia. *Proc. U.S. Nat. Mus.*, 12 (1889): 641–642.

Chapman, Wilbert M., and Allan C. DeLacy
1933 Notes on the fishes of the state of Washington. Copeia, 1933 (2): 102–103.

Clemens, W. A., and G. V. Wilby
1946 Fishes of the Pacific coast of Canada. *Bull. Fish. Res. Bd. Canada*, 68: 1–368, figs. 2–253, pl. 1.

Evermann, Barton Warren, and Edmund Lee Goldsborough
1907 The fishes of Alaska. *Bull. U.S. Bur. Fish.*, 26 (1906): 219–360, figs. 1–288, pls. 14–42.

Jordan, David Starr
1923 A classification of fishes including families and genera as far as known. *Stanford Univ. Publ., Univ. Ser., Biol. Sci.*, 3: 77–243, i–x.

Schultz, Leonard P., and Allan C. DeLacy
1936 A catalogue of the fishes of Washington and Oregon, with distributional records and a bibliography. *Mid-Pac. Mag.*, 1936: 127–142 (3rd installment).

Taranetz, A. J.
1941 On the origin and taxonomy of the cottoid fishes. *Bull. Acad. Sci. U.S.S.R. Sér. Biol.*, 1941 (3): 427–447, figs. 1–4.

U.S. National Museum, Washington 25, D.C.

Observations on the Habits and Early Life History of the Batrachoid Fish, *Porichthys notatus* Girard [1]

By Harbans Lall Arora

ASIDE from references to *Porichthys notatus* in purely systematic papers or in works dealing with photophores, only two papers (Hubbs, 1920, and MacGinitie, 1935) contain any information as to the life history and breeding habits of this fish. It is for the purpose of supplementing these investigations that my own observations are presented. It is fully recognized that they are not complete, but they do add to our knowledge of this interesting organism.

[1] I wish to express my gratitude to Dr. Rolf L. Bolin for his guidance and helpful suggestions throughout the investigation. To Augustin Fernandez Y. my thanks are due for assistance in the preparation of Figures 3 and 4.

The only species of *Porichthys* which overlaps *P. notatus* in range is *P. myriaster*. From this form *P. notatus* may readily be distinguished by the branchiostegal rows of photophores which unite in a broad V without a forward projection, whereas in *P. myriaster* the branchiostegal rows of photophores have a U-shaped forward commissure. In the former species the palatine teeth are small and somewhat compressed but in the latter they are large.

Porichthys notatus occurs abundantly along the Pacific coast from Sitka, Alaska, to the southern end of Lower California. Its habitat extends from the intertidal zone to depths as great as 145 fathoms. It is common in the bays from central California northwards whereas to the southward, according to Hubbs and Schultz (1939), it is largely if not entirely replaced by *Porichthys myriaster*. Hilton (1914) records one specimen of *Porichthys notatus* found in a pool in Laguna beach, south of the vicinity of Point Conception, California. However, since *P. myriaster* (not yet described in 1914) is the shallow water form of southern California, it is probable that Hilton had this latter species.

Most of the material was collected from the intertidal areas along the Monterey Peninsula coast, all of the eggs being taken on Mussel Point in front of Hopkins Marine Station (Lat. 36° 37′ 20″ N., Long. 121° 54′ 15″ W.). Some adults were brought in by trawls operating near Santa Cruz.

The adult fish is grotesque in appearance and is of dirty brown or greenish color. Usually the dorsal surface is uniformly dark in color but sometimes dark transverse bands may be seen crossing it. The head is somewhat depressed, the skin is scaleless and several lines of photophores are found on the sides of head and body. The photophores are associated with paired flaps which become fringed in the older fish. The species attains a length of about 15 inches.

Along the California coast this fish is known as midshipman, bullhead, cabezon, or singing fish. It gains the latter name from its habit of producing a peculiar grunting noise which sounds like "oonk." The sound is fairly loud and is produced by the air bladder, which is provided with muscular walls. I have heard the resonant croak with startling distinctness from a distance of about 40 feet.

Porichthys notatus, usually found in moderately deep water throughout most of the year, enters pools of the intertidal zone for breeding during the late spring and early summer. In the month of June, the spawning is at its peak. Most of the eggs were collected in the latter half of June and they were almost all in early stages of development. Estimating from parallel stages in the development of the related *Opsanus tau,* as reported by Gudger (1908), they were collected probably four to eight days after fertilization.

The parent fish resort to retreats under rocks or boulders partially embedded in sand or broken shell. They scoop out cavities underneath the stones by means of the pectoral fins, a process that has been recorded by MacGinitie (1935). The female then deposits her eggs in a single layer on the roof of the cavity. The eggs are thus well protected from the sweeping effect of waves.

No female was recovered in the twenty-one nests examined by me during the latter part of June. This leads me to the conclusion that soon after the deposition of the eggs the female departs. The male fertilizes the eggs and guards them until they are hatched and the larvae become free swimming (Plate I, Fig. 1). MacGinitie (1935) reports that parental care is exercised by the female. He states, "the females . . . after attaching their eggs to the rock, . . . lie in this hole and keep watch over the nest until the young become free." In the light of my own observations I find this statement to be in error. All of the specimens recovered from the various nests were dissected and the gonads subjected to microscopic examination, and the fish were all found to be males. This corroborates the observations recorded by Hubbs (1920).

The males found in these nests were sluggish; whenever one was disturbed, it would wriggle into a nook or cranny. I never found a nest without a guarding male, and it appears that the male never leaves the nest until the young ones become free swimming. The examination of the stomach contents revealed that most of the males were starved. They fulfil their food requirements with whatever little is found in the nests.

It is of interest to note that the nest remains perfectly clean. This cleaning is accomplished by the fanning movement of the pectoral and caudal fins of the guarding fish. This has been confirmed by an experiment performed by me on July 10, 1946. Two nests were brought into the laboratory and placed in separate aquaria. In one of these aquaria the guarding fish was left with the nest but from the other aquarium the fish was removed. After a few days the eggs in the former tank remained clean and showed normal development whereas in the latter a white bacterial scum was seen over a small patch of eggs. These became dirty white and eventually decayed. The parent fish in the former nest brushed or rubbed against the egg mass and entangled all of the debris, sand particles and organic detritus from the surface of the eggs in the mucus with which it was copiously covered, thus keeping the eggs clean.

Another experiment, showing fighting tendencies on the part of the toad-fish in defense of the eggs, was performed on the same day. A nest with the guarding male was placed in an aquarium. Into the same aquarium, another male from a different nest and of somewhat smaller length was also introduced. After a few hours there was a great commotion in the tank; the two fishes were fighting with each other. By next morning, the larger fish had almost torn out the lower jaw of the smaller one and had the head in its jaws. The defender of the nest had also ripped through the body wall of his adversary so that the entrails were exposed and some of the intestines were trailing out. The half-dead smaller fish was released by striking the larger individual with a rod. This type of defensive behaviour on the part of *Porichthys* has been observed frequently by members of the summer classes at the Hopkins Marine Station, Pacific Grove. If an observer suddenly thrusts his face close to the glass wall of an aquarium containing a toad-fish nest, the attendant male will usually open his mouth widely as if preparing to bite and will simultaneously emit a harsh bark or croak.

Besides cleaning, and guarding the eggs from the enemies, the parent fish

protects them from desiccation during low tide periods when the water recedes to a very low level and the nests are exposed to air. At times I have noticed the parent fish fluttering its pectorals and splashing water from the cavity over the eggs. The toad fish itself possesses a remarkable vitality and is very resistant to lack of water. If taken out of water it can be kept alive for about 8 hours in moist sand.

The eggs are spherical or subspherical in shape and average about 6 mm. in diameter. They are orange and resemble salmon eggs both in size and color. The egg membrane is quite firm and is not easily broken. The attachment of the eggs to the rock is brought about by an adhesive disc, which is a transparent secretion present at the vegetative pole of the egg at the time of deposition. On coming in contact with water, this secretion becomes opaque and gluey.

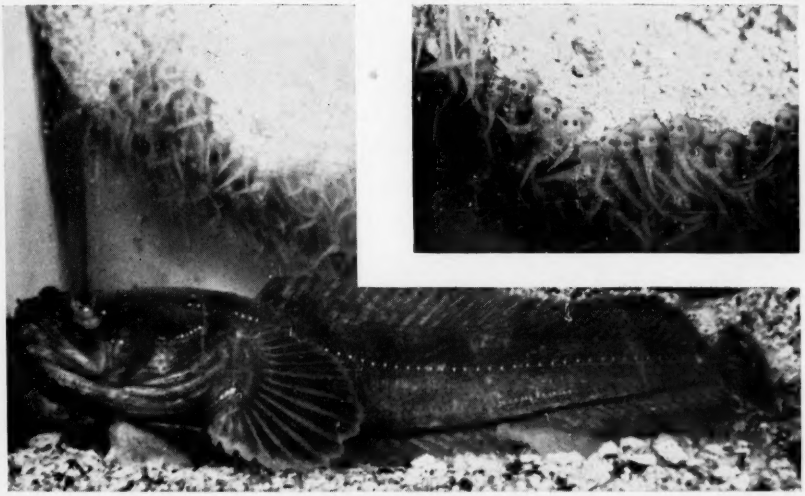
The number of eggs in different nests varied considerably, from 19 to 789, but the usual number was from 200 to 500. In some nests the eggs were laid in separate patches. In others, where they were laid in one continuous layer, clearly circumscribed areas displayed ova in different stages of development. In one nest the eggs displayed great disparity in size, those in one sharply defined segment being about 4 mm. in diameter, while in the remaining part of the continuous mass they measured about 6 mm. These facts lead me to the conclusion that the fish is polygamous and that several females contribute to an individual nest. Furthermore, the size of the ovary suggests that one female cannot lay a great number of such large eggs at one time.

In spite of hard search, no mature female was found in the tidal pools during the later half of June and hence no artificial fertilization of the eggs was possible. Of the eggs recovered from the nests, those in the earliest stages of development showed a blastodermic cap. In others, slightly older, the axial thickening was well developed while in some the young fish-like embryo was clearly visible through the egg shell.

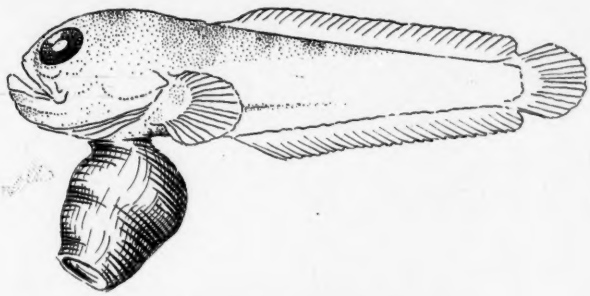
At the time of hatching the egg membrane becomes weak and the little fish bursts the part of the shell over the tail so that this structure protrudes and may be seen lashing freely in the surrounding water. The split continues forwards and downwards and uncovers not only the embryo but also the upper part of the yolk as well. The embryo after hatching is well advanced and looks like a young tadpole. Its length is about 7 to 8 mm. The shell breaks at about 12 to 16 days after the blastodermic-cap stage, so that the period of incubation is probably from 16 to 20 days. The newly hatched young remain fixed to the rock, even after hatching, by means of the yolk sac, which is attached to the adhesive disc of the shell. The young larvae remain in this condition for about one month after hatching, during which period growth takes place at the expense of the yolk. Among the notable advances are the development of the caudal and median fins; the forward growth of the pelvics to their permanent position; the development of the gill covers and the pectoral fins to a stage of functional activity; the spreading of the vascular system over the yolk, and the more rapid growth of the mouth and head parts (Plate I, Fig. 3). The pigments and photophores begin to appear. The yolk remains spherical as long as the egg membrane is

1

2



3



4

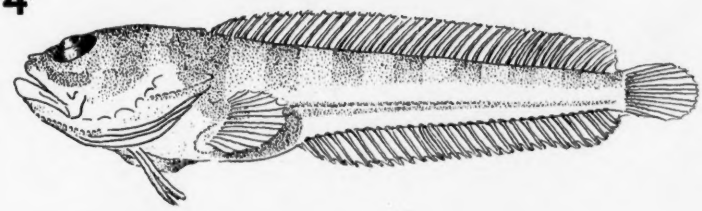


Fig. 1. Male guarding the nest.
Fig. 2. Young larvae after hatching.
Fig. 3. Larva 17 days after hatching.
Fig. 4. Young free swimming larva just after leaving its anchorage.

UNIV. OF MICH.

intact, but after the shell bursts, the yolk begins to exhibit a variety of shapes. At times it elongates and becomes pyriform, having a small constriction at or near the middle; a few hours later, it is drawn out into a pillar-like body; then it rounds up and may go through the same series of changes again, not necessarily in the same sequence. These rhythmical movements of the yolk are due to the action of muscular fibres in the wall of the yolk sac.

The yolk is absorbed slowly. Finally, when the larva is about 29 mm. in length and shows dark cross bands, a marked constriction divides the yolk into two parts, the upper small bulb being slowly absorbed by the downward growth of the mesoblastic somites on either side of the yolk bulb. Later on, the constriction travels downwards and the lower bulb is engulfed by the larva and becomes largely intra-abdominal. Finally there is nothing left except a disc-like plate filled with blood vessels. The larva at this stage is fairly advanced and is ready to leave its anchorage.

The young fish, which now look decidedly like their parents, appear very restless, lashing their tails to right and left while the pectorals perform slow fanning movements. The larvae twist back and forth and break loose from the rock to become free swimming. They are about 32 to 34 mm. long at the time of detachment. The attachment disc drops off, leaving a knob-like projection which is later absorbed. The free swimming larvae (Plate I, Fig. 4) avoid light and keep buried in the sand during the day but at night they come out and feed upon small crustacean larvae and other zooplankton. Eventually they migrate to deeper waters.

Literature Cited

Gudger, E. W.
1908 Habits and life history of the toadfish (*Opsanus tau*). *Bull. U.S. Bur. Fish.*, 28: 1071–1109.

Hilton, W. A.
1914 Record of two fishes not before mentioned from Laguna. *Jour. Ent. and Zool.*, 6: 233.

Hubbs, Carl L.
1920 The bionomics of *Porichthys notatus* Girard. *Amer. Nat.* 54: 380–384.

Hubbs, C. L., and L. P. Schultz
1939 A revision of the toadfishes referred to *Porichthys* and related genera. *Proc. U.S. Nat. Mus.*, 86 (3060): 473–496.

MacGinitie, G. E.
1935 Ecological aspects of California marine estuary. *Amer. Midl. Nat.*, 16: 629–765.

Hopkins Marine Station, Pacific Grove, California.

The Use of Rotenone for Collecting Reef and Lagoon Fishes at Bikini [1]

By Leonard P. Schultz

THE usual methods of collecting fishes, such as baited hook and line, trolling, spearing, dredging, attracting them to a surface light at night, and by the use of various nets, were employed at Bikini. More important was the use of powdered plant roots to stupefy fishes, and since our methods of using it on coral reefs are unpublished, they are herein described. Powdered cubè or derris root with a five per centum of rotenone content has been used by various ichthyologists for over 40 years to collect fishes for scientific purposes. Dr. Carl H. Eigenmann, during field work in South America in 1908, probably was the first ichthyologist to use vegetable poisons, although aboriginal natives in nearly all parts of the world have made use of them. Since that time most American ichthyologists have used vegetable poisons to collect fishes for scientific purposes. Drs. Eigenmann and W. R. Allen, University of Kentucky, describe methods of collecting freshwater fishes, in their 1942 publication, *The Fishes of Western South America.*

From 1936 to 1938, I experimented with the use of powdered derris root in freshwater streams and during the second World War with the rotenone-extract. However, the latter did not appear to be as effective as the powder. It was not until 1939 that an opportunity came to carry on extensive experiments. Upon arrival in the Phoenix Islands, I found practically no enclosed tidal pools such as those in which ichthyologists had previously used rotenone fish poisons in small quantities. The reefs were flat, pavement-like structures, with narrow to wide channels, connected with open water, whereas the deepest isolated pools left at low tide were only a few inches deep and often lacked fish.

A large variety of fishes could be seen swimming in the channels, in the open waters, and even in the ocean surf. These had to be secured in some way. After carefully studying the currents, and estimating the amount of water, I attempted the use of rotenone in the open water among the corals and algae. At the end of July, 1939, after four months of continuous use in various coral reef habitats, methods of using rotenone in open water situations had been perfected, and as a result over 14,000 excellent fish specimens were recovered for the United States National Museum.

When I was asked late in 1945 about obtaining samples of shallow water reef fishes at Bikini, Operation Crossroads, for purposes of determining the relative abundance of fishes before and after the atomic explosions, I suggested the methods developed in 1939. A few months later, during March to August, 1946, and again in July and August, 1947, fishes were collected by use of rotenone. Different techniques were applied depending on the situation. As a result, over 70,000 fish specimens were taken on which systematic and population studies could be based. Part of these were discarded after data from them were recorded.

Thirty-five minutes before the tide reached its lowest point, the dry powdered root was placed in buckets or any suitable container and mixed

[1] Published with the permission of the Secretary of the Smithsonian Institution.

with water to a thick chocolate malted milk consistency, allowing about 20 minutes for one man to mix 25 pounds. By squeezing and stirring with the hands, as water was gradually added the powder soon formed a thick mud. Ten minutes before low water, the distribution of the mixture began. The stupefying of a great variety of fishes with rotenone was most effective at the lowest stage of water.

The success of this operation depended on determining the strength of the currents and depth of water. A little of the mixture was tossed into the water and the direction of movement of the small, light brownish cloud, watched. After several such tests, assistants, each with a bucket or two of the "mud," were stationed in the water and the distribution began. In water 4 to 5 feet deep, with a slight current, the mud was thrown out, permitting the little pellets to dissolve as they settled toward the bottom, forming a light brownish cloud. Twenty-five pounds of the dry powder formed a cloud about 100 to 150 feet long by 50 to 75 feet wide. It was highly effective if it took 10 minutes to pass any one point in water above 80° F. When used at lower temperatures the fish must be exposed for a longer time. Usually a part of a bucket of the mud was reserved to strengthen the cloud after it had traveled a few hundred feet. This precaution was advisable, since the currents did not always behave as predicted.

Shallow Water Reef

It was learned through experience which shallow water habitats (to a depth of 10 feet) were suitable for collecting fishes with rotenone. An area with an abundant growth of coral heads in about 3 to 4 feet of water, down to 10 feet in pools, with narrow to wide channels between the various kinds of corals, and a wind blowing the surface water more or less shoreward, was the most ideal situation.

Many kinds of fishes in the areas treated floated for a few minutes, then sank to the bottom. Some were picked up while they were violently swimming more or less in circles. A greater number appeared at the surface than were recovered immediately. Those that drifted ashore were recovered but those that got over deep water were often lost.

Immediately after introducing the rotenone, recovery of the fish started, but it was inadvisable to enter the area in which the treated water would flow, since that drove the unaffected fishes away. As soon as the water cleared, those that settled to the bottom were collected. Two or three men continually wandered over the treated area, picking up the specimens in fine-meshed, bobbinet dipnets, 14 or 15 inches in diameter and 25 to 30 inches deep, with a 4- or 5-foot-long lightweight wooden handle.

As the water-laden cloud of rotenone drifted onward for a thousand feet or more, it spread out, gradually becoming so diluted that it lost its effectiveness. When the water appeared as a light, tan-colored cloud, it was most effective, since it retained its stupefying properties yet was not so much concentrated as to be detectable by most fishes. Sharks, apparently able to detect small amounts of the rotenone in the water, left the area until the cloud had passed. Then they returned to feed on the sick and dead fishes, sometimes becoming troublesome. With only one or two 3- to 6-foot-long sharks feeding on the sick fishes, a skin diver can keep watch of them.

However, when two or three of these voracious creatures became too bold, as on one or two occasions, the ichthyologists left the water.

The searching for the demobilized fishes was done by means of a face mask covering eyes and nose, swim fins on the feet, and a dipnet. With a face mask, both hands were free to devote to picking up fishes, some of which were rather slippery. A canvas glove as an aid for holding slippery fish was used on one hand when necessary. Some of the fishes affected appeared lifeless, but when touched were found to be very much alive and quickly moved away unless caught in the dipnet. Those too small to pick up with the fingers were, with a little practice, lifted from the bottom by inducing upward currents through rapid movement of the hands or feet. A fish, thus suspended for a few moments, was scooped up in the dipnet. Desirable fishes frequently swam into the crevices of the corals and erected their spines, making their removal difficult. With clear vision through the face mask, these, too, were collected.

A rubber boat, tied to one of the coral heads, served as a base from which to work and was an added safety in case someone ran into trouble due to the rugged conditions under which we worked. This boat held the preserving tank, and other gear. Three good swimmers at Bikini usually picked up enough fishes to keep one man busy preserving the specimens in the rubber boat. On shore, one ichthyologist and a Navy photographer took over 200 good color pictures.

Those fishes first to be affected by the rotenone were the damsel, cardinal, butterfly, surgeon, and puffers; others such as needlefish, halfbeaks, goatfishes, gobies, jacks, threadfins, and mullets were a little slower in reacting to the treated water. The burrowing fishes, namely, eels, appeared last, probably because it took longer for the rotenone to diffuse into their habitats. Fish continued to appear for over 6 hours after treatment, and I recovered eels that came out 8 hours after the cloud had passed their burrow.

Care was exercised in picking up supposedly dead spiny fishes, and especially moray eels, since they may inflict serious wounds. Scorpion fishes, siganids, and other venomous species, even the stinging corals and jelly fishes, were treated with respect.

The snake eels often appeared with about 6 to 12 inches of their head section above the bottom. I grabbed them firmly and quickly, then pulled out the remaining 2 or 3 feet of their bodies. A light touch or a miss usually caused the eel to withdraw into its burrow and the specimen was lost.

The rotenone appeared to affect the fishes by constricting the capillaries of the gills, depriving the animals of an adequate oxygen supply. They leave their hiding places for more oxygen, thus exposing themselves under a weakened condition and simplifying their capture.

Shallow tidal pools that trap fishes at low tide are simple to work, but the use of rotenone in the ocean surf on the ocean reef of a coral atoll requires special technique.

Lithothamnium Ridge

The outer margin of an atoll rim on the ocean side usually consists of the slightly raised pink- to red-colored lithothamnium ridge contrasting beautifully with the deep blue ocean beyond. It is dissected by rugged

surge-channels, and deep pools often 20 feet deep directly connected with the ocean. This ridge, creviced and pitted with holes, is about a foot or two higher than the flat part of the reef farther inward. At extremely low tides it is exposed except as the surf crashes over it, then some of the water is forced back over the flat part of the reef, flowing seaward again through the surge-channels.

Some of the surge-channels, extending for a hundred feet or more back into the solid reef, are more or less roofed over or have perforations large and small through which the water may pour or spout on the incoming surge of a wave. They are lined with rich green and red algae, blue, red, yellow and green corals, and a host of brilliantly colored fishes live in these clear waters.

Rotenone was used successfully along the lithothamnium ridge in the ocean surf. The "mud" was administered a few minutes after the low point of the tidal cycle. An area was selected where pools occurred but which were not completely connected with the surge-channels. These pools were desirable as settling basins for the sick and dying fishes. The area between two or three surge-channels, where the waves flow inward across the ridge, was the place where we applied the rotenone mixture. Big handfuls of the thick mud were thrown out as far as possible into the backwash of a wave. The next moment the oncoming breaker churned the water into foam and carried the water-laden cloud of rotenone inward, spreading it over the area and into the numerous crevices, then it flowed out the surge-channels. Soon the rotenone cloud was distributed along the ocean edge of the reef, and some was brought back again over the lithothamnium ridge. The continual surging inward of the water brought in the sick fish. Men were stationed along the surge channels to take those that were being swept out to sea and perhaps lost. After the pools and channels cleared, the bottoms were searched for fishes by the skin divers.

The use of a face mask in skin diving and swimming enables one to see clearly for 50 to 100 feet in the lagoon and ocean waters. Looking down in the surge-channels between the corals, one sees a gorgeous display, a colorful marine garden of coral, algae and fishes. Some of the corals are fan-shaped, others resemble the antlers of deer. They are blue, bright green, red, brown, yellow, and purple, contrasting with the white foraminiferal sand of the bottom.

The light from the tropical sun flickers down into these enchanted caverns, filled with the blue sea. The trembling shafts of light illuminate the green, brown, and red algae, waving in the dim light. Fantastically shaped fishes, as if from another world, dart about, reflecting their weird color combinations of brilliant blues and sapphires, greens, and yellows, red or scarlet, and with black and white markings contrasting sharply. Some have big red spots, others sapphire-blue bars and dazzling yellow and crimson stripes.

Butterfly, damsel, surgeon fishes and wrasse swim lazily about in the aquatic caverns and channels, but the moment a large predaceous fish appears they seek protection, disappearing and reappearing among the coral growths. Some swim as easily sideways and upside down as in a normal position. The view of this gorgeous marine garden fades away into nothingness a hundred feet or more below.

Deep-Water Use of Rotenone

Vernon E. Brock and Dr. Earl S. Herald, two ichthyologists who are excellent swimmers and skin divers, successfully carried on several deep-water poisonings of fishes with powdered cubè root. They mixed in the usual manner about 35 pounds of the substance, then placed 5 to 10 pounds of the "mud" in desert water bags. Equipped with standard U.S. Navy shallow water diving outfits, Brock and Herald took the rotenone to the bottom, distributing it around coral growths. Down below with the usual dipnets, they recovered fishes, bringing them to a man at the surface, who preserved the specimens. This deep-water work was necessary to obtain a more complete picture of the fish fauna of Bikini and the change in kinds of fishes at various depths in the lagoon. Several fish species occurring over the shallower parts of the reefs normally are not found at depths below 10 to 20 feet, whereas some kinds found below that depth are not taken near the surface.

Collecting With A Light At Night

A bright light suspended from a small ship at night at the surface of the sea attracts to it myriads of nocturnal organisms—crustaceans, worms, squid, octopi, and numerous species of fishes. Silversides, small wrasse, round herring, the pelagic stages of goatfishes, surgeon fishes, puffers, lizard and file fishes dart in and out of the field of illumination. Large flying fishes, a foot or two long, come swimming or flying toward the light at night. Down below a few feet, larger predaceous fishes can be seen rushing about feeding on the abundant animal life. Eager collectors gathered above this light on a platform, scooped up the animals with fine-meshed dipnets, and preserved them for future study.

Several kinds of fishes and invertebrates, taken around the light, were never collected by any other means at Bikini.

Underwater Television

At Bikini, in 1947, I saw demonstrated the Navy's new underwater television, prepared and operated by the Cornell Aeronautical Laboratory, Buffalo, New York. The camera end of this remarkable device was set up on the deck of the sunken submarine, *Apogon,* in 160 feet of water. It was sufficiently sensitive to daylight to give clear and precise images on the screen in the control and observation room of the *U.S.S. Coucal.* The color patterns of fishes were portrayed in pale greenish light with distinctness as they swam in front of the lens. I identified with ease two species of pigfish (*Lethrinus*), the trumpet fish *(Fishtularia)*, a jack *(Caranx)*, the moorish idol *(Zanclus)*, and *Siganus punctatus.*

This apparatus opens up new fields of investigation in the study of aquatic animals in their natural habitats. Scientists and laymen who wish to study animal behavior will be able to do so without the dangers of deep-water diving. The applications of underwater television to biological research are in the same magnitude as the discovery and first use of the microscope.

U.S. National Museum, Washington, D.C.

Comparison of Calculated Fish Lengths Based on Scales from Different Body Areas of the Sardine, *Sardinops caerulea*

By J. B. Phillips

Introduction

During the course of the age analysis work on the sardine, *Sardinops caerulea*, found along the Pacific coast of North America, some variation was observed in the readability of scales taken from different parts of the body. Scales taken from near the mid-line of the back, from just behind the head, from near the mid-ventral portion of the body, and from near the base of the tail were not satisfactory. Scales from these areas may be misshapen, or the annular markings may be marred and interrupted by excessive scarring, thereby causing uncertainty in the identification of annuli. Practically all other scales along the sides of the body are satisfactory provided they are not regenerated. The following study was made to ascertain the extent of variability in the calculated fish length at the formation of the first annulus based on scales taken from different parts of the body. The results indicate that minimum average differences in calculated lengths are obtained from scales taken in a zone extending from the pectoral fin upward and backward on a diagonal to the lateral line area and ending midway between the anterior insertions of the pelvic and anal fins.

Methods

Twelve sardines from California waters, ranging in size from 170 to 261 mm., body length,[1] and whose scales showed a clear-cut first annulus, were selected for this study.

The fish were one to eight years in age. Scales were taken from thirteen different areas on each fish. To define these areas four horizontal lines were assumed to intersect five vertical lines. The key horizontal line extended backward from the terminus of the latero-sensory canal system directly behind the eye. Although there is no lateral line along the sides of the sardine, this row for convenience has been termed the "lateral line row." The first horizontal line was the second scale row above the lateral line row, backward from about the top of the opercle. The next line was the lateral line row; the third line, the second scale row below that of the lateral line row, and the fourth horizontal line the fourth scale row below the lateral line row, or about off the tip of the pectoral fin. The five vertical lines were: off the tip of the pectoral fin; at the anterior insertion of the pelvic fin; halfway between the anterior insertion of the pelvic fin and the anterior insertion of the anal fin; at the anterior insertion of the anal fin; and at the posterior insertion of the anal fin. Scales were selected at the intersections of the horizontal and vertical lines (Fig. 1).

The selected scales were mounted dry, between two glass slides taped together at the ends. The scale images were magnified to thirty diameters

[1] Body length is from tip of snout with jaws closed to the termination of the fleshy portion of the body at base of caudal fin. Body length is about 85 per cent of total length.

by means of a projecting microscope (Walford and Mosher, 1943a). For the comparison of calculated fish lengths based on scales from different body areas, each scale was measured along its mid-longitudinal axis from the base of the sculptured area (focus) to the first annulus and to the margin. In addition, the greatest length and breadth of each scale were measured. Also, diagonal measurements from the focus to the anterior shoulders of each scale from area one were made in order to compare calculated lengths with those based on the mid-longitudinal measurement (Fig. 2).

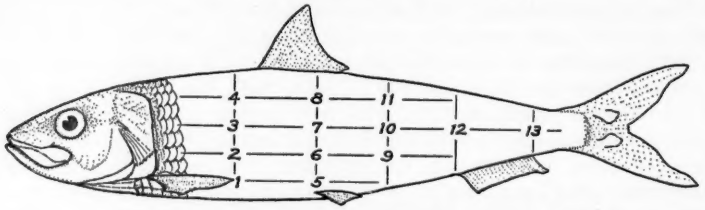


Fig. 1. *Sardinops caerulea.* The numbers at the intersections of the horizontal and vertical lines indicate the areas from which scales were selected.

Lengths of Fish Calculated to First Annuli

Tabulated in Table I are the calculated lengths [2] of the fish in millimeters at the formation of the first annulus, for the thirteen areas of each of the twelve fish. Also listed are the average of the calculated lengths for all areas of each fish, and the average of the calculated lengths for each area of all fish. The last column in the table labeled "Average difference" lists the difference of the average calculated length for each area from the average (105.3 mm.) of all areas of all fish.

For the average of the series of twelve fish, the greatest difference between the calculated lengths is found in scales taken from area thirteen, in the caudal peduncle region, and scales taken from area four, near the back between the head and the anterior insertion of the dorsal fin. Area thirteen yields fish lengths that are 8.9 mm. greater than the average for all areas combined, while area four yields measurements that are 5.7 mm. less, a total difference of 14.6 mm.

In general, scales that yield the greatest calculated lengths to the first annuli are found in the areas that form the posterior and postero-ventral region of the body; scales that yield the least calculated lengths to the first annuli are found in areas that form the antero-dorsal and dorsal region of the body. A zone in which minimum average differences of calculated lengths are found extends from the pectoral fin upward and backward on a diagonal to the lateral line row, midway between the anterior insertions of the pelvic and anal fins.

[2] Fish length to the first annulus was calculated by the following formula:

$$f_1 = \frac{s_1 F}{S}, \text{ where,}$$

f_1 is length of fish at formation of first annulus;
F is length of fish at time of observation;
s_1 is length of scale from focus to first annulus;
S is length of scale from focus to margin.

TABLE I

CALCULATED LENGTH, BY SCALE AREA, OF FISH AT TIME OF FORMATION OF FIRST ANNULUS FOR THE TWELVE FISH USED IN THE STUDY

Area of Scale Selection (*See* Fig. 1)	Body Length of Fish in Millimeters											Average	Average Difference
	170	175	186	195	201	208	218	224	233	241	255	261		
1	100.0	120.6	80.9	114.4	105.6	89.1	89.6	99.3	115.3	97.5	146.3	108.5	105.6	0.3
2	98.2	120.3	80.3	113.0	101.2	90.1	91.1	95.6	116.5	89.6	140.0	109.1	103.8	−1.5
3	93.5	119.8	75.1	108.6	99.1	83.5	86.8	93.3	114.6	90.4	144.9	115.7	102.1	−3.2
4	94.6	117.7	76.9	107.7	98.0	82.4	84.8	89.0	110.8	84.9	139.2	109.8	99.6	−5.7
5	103.6	124.0	85.6	112.6	106.5	90.5	92.2	107.5	117.2	98.0	154.7	110.5	108.6	3.3
6	99.4	123.1	76.3	111.5	104.0	85.2	94.4	95.7	113.9	92.7	152.0	110.0	104.8	−0.5
7	96.4	117.9	77.1	106.3	100.5	82.0	88.2	96.9	112.4	90.0	147.6	107.6	101.9	−3.4
8	98.1	118.7	74.7	110.0	100.5	82.2	89.8	97.5	109.2	86.1	142.0	113.3	101.8	−3.5
9	99.6	120.1	80.4	110.5	108.3	85.5	89.5	101.3	116.5	95.5	151.6	106.2	105.4	0.1
10	98.4	121.1	77.3	112.2	103.8	86.5	90.7	99.9	120.1	97.0	155.8	112.6	106.3	1.0
11	100.6	119.5	69.8	112.4	105.2	86.9	89.6	97.2	115.1	95.3	152.0	114.8	104.9	−0.4
12	106.1	119.3	80.8	114.1	106.9	93.8	95.7	100.5	121.6	101.7	160.3	119.2	110.0	4.7
13	109.7	125.0	89.1	117.5	108.7	95.6	100.4	109.6	126.6	108.3	159.9	120.5	114.2	8.9
Average	99.9	120.5	78.8	111.6	103.7	87.2	91.0	98.7	116.1	94.4	149.7	112.1	105.3	

Kaganovskaya (1937), in working on the sardine, *Sardinops melanostica,* found in Russian waters, divided the body into seven sections for a somewhat similar study of the scales. He concluded that the most authentic data concerning the growth of the sardine can be obtained from scales taken from before and under the dorsal fin below the middle line of the body. This includes the zone of minimum average differences as indicated in the present study.

Greatest Lengths and Breadths of Scales from Various Body Areas

Measurements of the greatest lengths and greatest breadths of the scales from the thirteen areas of each of the twelve fish furnish information about the maximum dimensions of the scales on the different parts of the body, and also permit comparisons between these maximum dimensions and the usual measurements of the scales from the base of the sculptured areas to the margins.

Table II

Average Sizes of Scales for the Corresponding Areas of the Twelve Different-Sized Fish. (All Measurements at ×30)

Area of Scale Selection (*See* Fig. 1)	Greatest Length of Scale	Greatest Breadth of Scale	Length and Breadth Combined (÷2)	Length of Scale From Focus to Margin
1	267	249	258	154
2	238	283	261	157
3	246	287	266	160
4	224	233	229	134
5	254	243	249	147
6	242	287	265	156
7	251	290	271	166
8	229	243	236	137
9	245	256	251	152
10	261	279	270	175
11	240	245	242	146
12	239	249	244	158
13	190	202	196	125

Tabulated in Table II are the average scale sizes for corresponding areas of the twelve fish. Averages include the greatest lengths, greatest breadths, greatest lengths and greatest breadths combined, and lengths of scales from foci to margins measured along the mid-longitudinal axis.

Scales of the greatest average length occur in area one, at the tip of the pectoral fin and in area 10, which is in the lateral line row, midway between the anterior insertions of the pelvic and anal fins. Scales of the next largest length occur in area five, near the base of the pelvic fin, and area seven in the lateral line row below the dorsal fin. Scales having the shortest length occur in area thirteen on the caudal peduncle. The next shortest scales are found in areas four and eight, which are near the middle of the back in the anterior portion of the body. In general, scales having the greatest average length occur in the zone from the tip of the pectoral fin, upward and backward to the lateral line, about midway between the anterior insertions of the pelvic

and anal fins. This corresponds to the zone of scales from which calculated fish lengths at the formation of the first annuli show a minimum of deviation from the average.

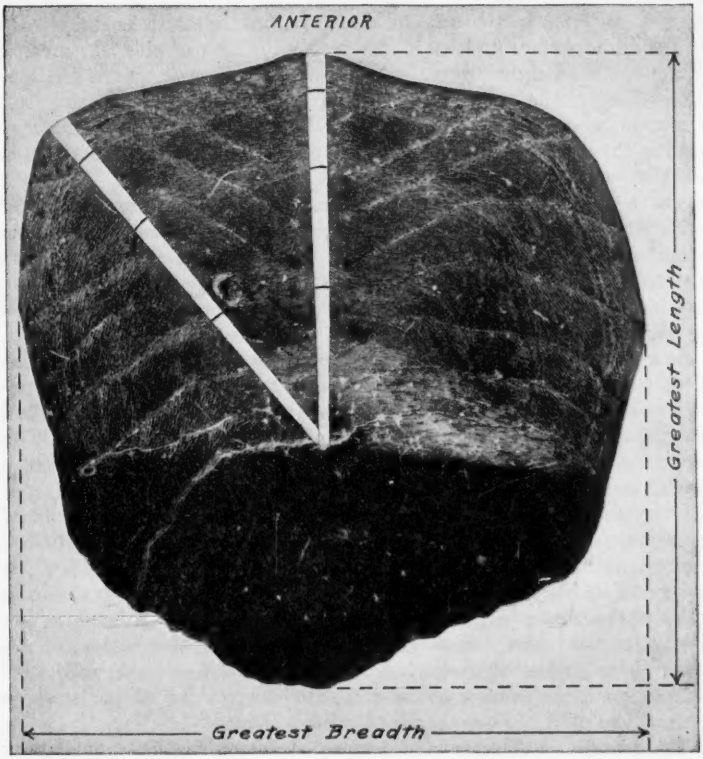


Fig. 2. Photograph of sardine scale showing the mid-longitudinal and diagonal measurements from focus to margin, also the greatest length and greatest breadth measurements.

Photograph by Kenneth H. Mosher, U.S. Fish and Wildlife Service.

Scales of the greatest breadth occur in area seven, in the lateral line row under the dorsal fin. However, there are five areas in which the scales are outstandingly broad, namely, areas 2, 3, 6, 7 and 10, collectively forming a broad zone along the middle of the sides. The area in which scales are the least broad is area thirteen, followed by areas 4, 5 and 8.

A combination of the length and breadth measurements gives a value that is more in keeping with the actual magnitude of the scale. Such a combination in the present study reveals that scales of the largest size appear in the adjacent areas seven and ten, which are in the lateral line in the central portion of the body.

Comparison of Greatest Sizes of Scales with the Usual Scale Measurements from the Focus to Margin

In comparing the greatest dimensions of scales with the usual scale measurement, from focus to margin along the mid-longitudinal axis, the following coefficients of correlation were obtained: greatest length of scale and the distance from focus to margin resulted in an r of plus .79; greatest breadth of scale and the distance from focus to margin gave an r of plus .86; greatest length combined with greatest breadth and the measurement from focus to margin resulted in an r of plus .91. In each of the foregoing comparisons, the probability (P) is less than one in one hundred of arriving at such high values by chance alone, if there were no correlation.

The results of these tests indicate that the measurement used in the regular scale-reading program, namely, from the focus to the margin of the scale along the mid-longitudinal axis, is more closely associated with the greatest breadth of scale than with the greatest length of scale. However, there is an even closer association when the greatest length and breadth are combined.

As a result of these tests, a series of transverse measurements was undertaken. But it became apparent that errors in the placement of the measurements were great, and this phase of work was abandoned. In the longitudinal scale measurements the focus is taken as the base of the sculptured area. This base is not the widest part of the scale and therefore cannot be used as a point of reference for the focus in a transverse measurement.

Although the best statistical correlation resulted when the combined lengths and breadths of the scales were compared with the longitudinal measurement from focus to margin, such a measurement is not practical. As a compromise, therefore, a series of diagonal measurements from the focus to each of the two anterior shoulders of a scale was made (Fig. 2). Area one, for each of the twelve fish ranging from 170 to 261 mm. in length, was chosen for this series of comparisons. It is a well-defined area, with small deviation from the average of the calculated lengths for all the areas on a fish.

The average of the calculated lengths of fish to the first annuli show identical values for measurements of the scales made from the focus to the margin, along the longitudinal axis, and for the measurements of scales made along the diagonal to the antero-dorsal shoulder margin, namely, 105.6 mm. The average of the calculated lengths to the first annuli for measurements made along the diagonal to the antero-ventral shoulder margin is 101.6 mm., 4 mm. less than that obtained by the other two methods.

The greater disparity in the calculated lengths resulting from measurements made along the antero-ventral diagonal of the scale is most likely due to scale distortion on that side. A considerable distortion occurs in the ventral portions of the scales that border the upper edge of the pectoral fin. There is a gradual reduction of the ventral half of the scales progressing from the tip of the pectoral fin toward the base, and at the base the reduction is so great that the scales appear to be represented by their dorsal half, only. If there is little evident distortion in the two halves of a scale, the diagonal

measurements from the focus to the anterior shoulders of a scale are as reliable as the longitudinal measurement.

In older fish, the longer, diagonal measurement may serve as a substitute for the measurement along the longitudinal axis of the scale. Walford and Mosher (1943a) state: "In the scales of fish older than six years, the peripheral annuli are crowded and frequently irregular, so that they cannot be made out equally well entirely around their course, particularly in very old specimens. On such scales, the annuli are generally most distinct at the anterior corners of the sculptured part of the scale."

Summary

1. Measurements were made, at thirty diameters magnification, of scales taken from the same thirteen body areas in a series of twelve sardines that ranged from 170 to 261 mm., body length, and one to eight years of age.

2. Calculated lengths of fish at the formation of the first annulus based on scales from the thirteen areas of each of the twelve fish yielded an average difference of 14.6 mm. between the smallest and largest calculated lengths.

3. The greatest calculated lengths were associated with scales taken from the posterior region of the body, while smallest lengths were derived from scales taken from the antero-dorsal region of the body.

4. A zone of scales yielding minimum differences from average calculated lengths extended from the tip of the pectoral fin upward and backward on a diagonal to the lateral line row, midway between the anterior insertions of the pelvic and anal fins.

5. In general, scales having the greatest length occurred in the zone yielding minimum differences in calculated fish lengths.

6. Scales having the greatest breadth occurred in a zone below and including the lateral line row in the middle and anterior portion of the body.

7. Combined length and breadth measurements demonstrated that scales of largest size occurred in the lateral line row in the middle portion of the body.

8. A correlation analysis indicated that the usual, mid-longitudinal scale measurement from focus to margin is more closely correlated with the total breadth than with the total length of a scale, but there is an even closer association when breadth and length are combined.

9. Transverse measurements from focus to margin were impractical, chiefly because the greatest breadth of scale is usually some distance above the base of the sculptured area.

10. Diagonal measurements from focus to the anterior shoulders of a scale were as reliable as the mid-longitudinal measurement when there was little noticeable scale distortion. In cases of scale distortion the longer diagonal measurement would be the more reliable.

Literature Cited

Kaganovskaya, S. M.

1937 The validity of estimating length and rate of growth by scales from various sections of the sardine, (*Sardinops melanosticta*). *Bull. Pac. Sci. Inst. Fisheries and Oceanography*, 12: 115–124. Vladivostok, USSR.

WALFORD, LIONEL A., and KENNETH H. MOSHER
1943a Studies on the Pacific pilchard or sardine, *Sardinops caerulea*. 2.—The determination of the age of juveniles by scales and otoliths. *U.S. Fish and Wildlife Service, Special Scientific Report* No. 20. Mimeographed.
1943b Studies on the Pacific pilchard or sardine, *Sardinops caerulea*. 3.—Determination of age of adults by scales, and effect of environment on first year's growth as it bears on age determination. *Ibid.*, No. 21. Mimeographed.

BUREAU OF MARINE FISHERIES, CALIFORNIA DIVISION OF FISH AND GAME, PACIFIC GROVE, CALIFORNIA.

Two New Subspecies of the Salamander *Plethodon shermani*

By CLIFFORD H. POPE and NELSON G. HAIRSTON

WHILE making a detailed study of the *jordani-metcalfi* group of the genus *Plethodon* we have found it advisable to name two populations as follows:

Plethodon shermani ***rabunensis***, new subspecies

DIAGNOSIS.—A member of the *jordani-metcalfi* group with white spots on the cheeks and along the sides of the body. The legs are never red as in *P. s. shermani*.

TYPE.—Chicago Natural History Museum 47697, a female from Rabun Bald Mountain, Rabun County, Georgia, collected between 4,200 and 4,600 feet above sea level on August 3, 1946, by members of the C. H. Pope family.

PARATYPES.—CNHM 47698-47706, nine topotypes collected with the type; three series in the Carnegie Museum collected August 18 and 19, 1939, by Richmond and Green: 17781, seventeen specimens from Bailey Creek Forest Camp on Addie Creek, east slope of Rabun Bald Mountain, 2,400 feet elevation; 17790, twenty-five specimens from Rabun Bald Mountain parking lot, 4,000 feet elevation; 17812, forty-seven specimens from the west slope of the north ridge of Rabun Bald Mountain, 3,500 feet elevation.

RANGE.—Known only from Rabun Bald Mountain, Rabun County, Georgia, above 2,400 feet elevation.

DESCRIPTION OF TYPE.—An adult female, 118 mm. in total length, 62 mm. from snout to anterior angle of vent; 13 costal grooves; vomerine teeth 10-7.

The color is black above, shading into dark grey below; the throat is paler than the belly. There are white spots on the cheeks and on the sides of the trunk. The legs and tail, like the body, are slaty black above and paler below.

VARIATION.—The chief variation is in the amount of the white spotting; moreover, some fifteen per cent of the paratypes lack the spots entirely and are therefore indistinguishable from the subspecies described below. The largest male and female measure 71 and 70 mm. from snout to anterior angle of vent.

Plethodon shermani ***melaventris***, new subspecies

DIAGNOSIS.—An immaculate member of the *jordani-metcalfi* group with a black belly. This subspecies is remarkably uniform in color, never exhibiting the red legs of *P. s. shermani* or the white spots of *P. s. rabunensis*.

TYPE.—Chicago Natural History Museum 47614, a male from Highlands, Macon County, North Carolina, collected July 27, 1946, by Alexander Pope at 3,800 feet elevation.

PARATYPES.—One hundred twelve specimens in the Chicago Natural History Museum from North Carolina collected from July 1 to September 4, 1946, by Lydia Sargent and members of the C. H. Pope family, and tabulated below:

CNHM	LOCATION AND ELEVATION
45984–46000	Macon County: Highlands, 3,800–4,100 feet
47601–47613	" " "
47615–47689	" " "
47690	Macon County: 0.2 mi. from Chattooga River, 2 mi. upstream from meeting point of Ga., N.C., and S.C., 2,500 feet
47691–47693	Jackson County: Whiteside Cove, 4 mi. N. E. of Highlands, 2,800 feet
47694–47695	Transylvania County: top of Upper Falls of Whitewater River, 2,600 feet
47696	Transylvania County: Toxaway River, at site of dam of former Lake Toxaway, 3,000 feet

RANGE.—From Swannanoa, Buncombe County, North Carolina, southward into Greenville County, South Carolina, and westward to Highlands, Macon County, North Carolina.

DESCRIPTION OF TYPE.—An adult male 116 mm. in total length, 60 mm. from snout to anterior angle of vent; 14 costal grooves; vomerine teeth 10-11.

The body is immaculate black above and below; the throat is gray. The limbs are like the body in color.

VARIATION.—The paratypes exhibit no significant variation. The largest male and female measure 64 and 62 mm. from snout to anterior angle of vent.

A detailed study of the *jordani-metcalfi* group is in progress. Specimens of *P. s. rabunensis* and *melaventris* for many years have been identified as *P. metcalfi*; more recently by Grobman as *P. clemsonae*.

NORTHWESTERN UNIVERSITY, EVANSTON, and CHICAGO NATURAL HISTORY MUSEUM, CHICAGO, ILLINOIS.

Sexual Maturity in the Male Turtle, *Pseudemys scripta troostii*

By Fred R. Cagle

THE size or age of the male at attainment of sexual maturity has been but vaguely delimited for most species of turtles. Risley (1933) provides this information for *Sternotherus odoratus* and Hildebrand (1932) has indicated the size at sexual maturity for *Malaclemys*. Proper analysis of the growth history of an individual or population is difficult if the range of size and age at sexual maturity is unknown.

Turtles of the genus *Pseudemys* are usually sexed on the basis of the long preanal region and the long nails of the fore feet in the male. Identification of juvenile males or males in their first season of maturity as females may result from this procedure. Measurement of secondary sex characters taken from turtles collected from the City Lake at Carbondale, Illinois, and Lake Glendale, near Dixon Springs, Illinois, provide more adequate data for the determination of the attainment of maturity.

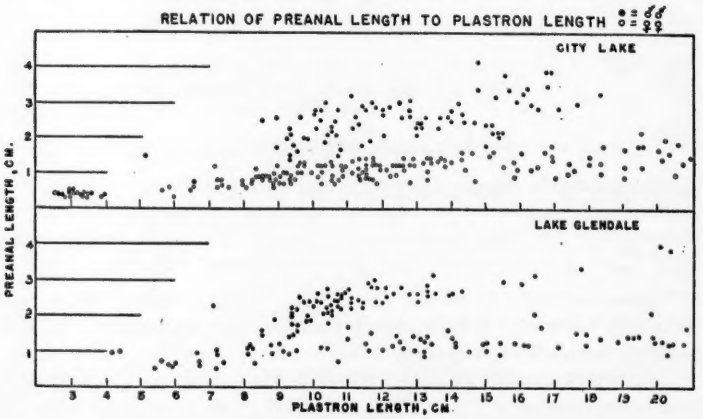


Fig. 1. The relation of preanal length to plastron length. Note the sudden increase in preanal length in individuals with 9–10 cm. plastron length.

The third claw was measured in a straight line from its base to its tip with Vernier calipers. The preanal length was measured from the rear edge of the plastron to the anterior lip of the cloaca. Experimental measurements indicated that the most consistent results were obtained when the turtle was held suspended by the tail until the muscles were relaxed. The sex of all individuals was determined by dissection. Males were classified as mature when smears indicated presence of sperm cells either in the testicle or the vas deferens.

The relation of preanal length to plastron length (Fig. 1) showed a marked change in males in both populations as they attain a plastron length of

9–10 cm. The preanal length of the males of this and larger sizes is clearly greater than that of any female of the same size group with the exception of two males in the size range 14–16 cm. collected from City Lake. No male greater than 10 cm. had a shorter preanal length than the female.

The relation of the length of the third claw to plastron length (Fig. 2) similarly changed abruptly in the size range 9–10 cm. in both populations. Only 4 males with mature gonads had not developed a lengthened preanal area or claws (Fig. 3).

Of 800 males examined from the City Lake, 1937–1946, only 4 with a plastron length less than 9 cm. were sexually mature. One mature individual was present in a sample of 8 males in the size group 8–9 cm. collected from Lake Glendale, November 16, 1946. Of 17 individuals 9–10 cm. in length, 14 were sexually mature and 3 were not.

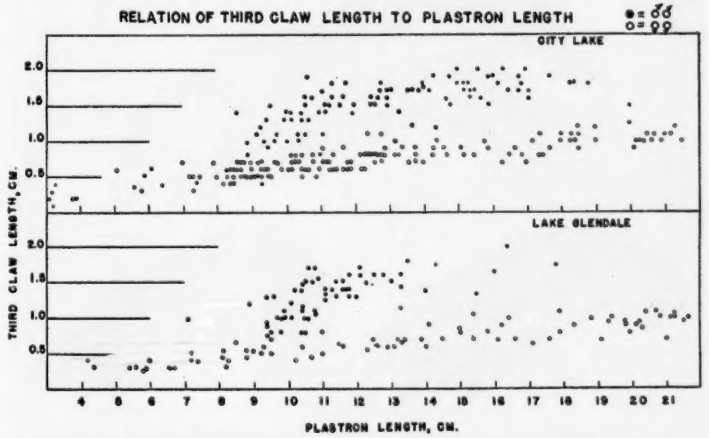


Fig. 2. The relation of length of third claw to plastron length. The first increase in third claw length is conspicuous in the 9–10 cm. size group.

It is of especial interest to note that the Lake Glendale population had a decidedly higher growth rate than the City Lake population in 1941–1946 (Cagle, 1946) yet the males attained sexual maturity at approximately the same size. The determination of exact age is difficult in most individuals but occasionally the growth rings are sufficiently distinct to indicate the age. This was possible in only 5 mature males from the City Lake population. These were 4 to 6 years of age. It was possible, however, to determine the age of most of the smaller mature males from Lake Glendale. This is undoubtedly a resultant of their more rapid growth. Individuals 7–8 cm. long were 1–3 years old; 8–9 cm., mainly 3, rarely 2; 9–10 cm., 3 or 4, rarely 5; 10–11 cm., 3–5; 10–12 cm., 3–5, mainly 4 or 5. Great variation in growth is implied in these data. Analysis of growth in this population is discussed elsewhere (Cagle, 1947).

Immature males grow rapidly, often in excess of 1 cm. per growing season.

It is thus apparent that the lengthening of the claws of the fore feet and the preanal area occurs within one season, or the period April to October in

Fig. 3. The comparison of the claws of the fore feet in juvenile males, juvenile females and adult males. 1. Male in its first season of maturity. 2. Juvenile female of same plastron length as the mature male. 3. Male in its second season of maturity. 4. A small male in its fourth or fifth season of maturity. 5, 6. Old males, upper a melanistic senile male.

Photograph by Cyrus Crites.

Illinois (Cagle, 1946). The herpetologist depending on these secondary sex characteristics for identification of sex may well make errors in individuals just becoming sexually mature (Fig. 3). Mature males may not have the

claws or preanal area conspicuously lengthened early in the growing season. Such individuals may be wrongly identified as juvenile females.

Males of this species thus normally become mature when they reach a plastron length of 9–10 cm. Occasionally individuals may become mature at a smaller size. The attainment of maturity is apparently a factor of size rather than age in the populations studied. Individuals in their first season of sexual maturity may be 2–5 years old. The rate of development of the secondary sex characters is in need of further investigation.

Literature Cited

Cagle, F. R.
1944 Sexual maturity in the female of the turtle, *Pseudemys scripta elegans*. Copia, 1944: 149–152.
1946 The growth of the slider turtle, *Pseudemys scripta elegans*. *Amer. Mdl. Nat.*, 36: 685–729.
1947 The slider turtles of Lake Glendale, Illinois. In press.

Hildebrand, S. F.
1932 Growth of diamond-back terrapins, size attained, sex ratio and longevity. *Zoologica*, 9: 551–563.

Risley, P. L.
1933 Observations on the natural history of the common musk turtle, *Sternotherus odoratus* (Latreille). *Papers Mich. Acad. Sci., Arts and Letters*, 17: 685–711.

Department of Zoology, Tulane University, New Orleans, Louisiana.

A New *Liolaemus* from Paraguay

By Benjamin Shreve

While identifying a recently received collection of reptiles from Paraguay I found the apparently new species described below. The locality, Fortin Guachalla, from which many of the specimens came, including the series described below, appears on the National Geographic Society's 1937 map of South America on the Argentine side of the Rio Pilcomayo; it may be assumed, however, that these lizards were collected in the vicinity of the Fort, but on the Paraguay side of the river. The region, just referred to as on the Paraguay side, was in dispute between Bolivia and Paraguay and is presumed now to belong to the latter since the ending of hostilities between the two countries.

Liolaemus ***chacoensis***, sp. nov.

Type.—Museum of Comparative Zoology, No. 49519, a male?, from Fortin Guachalla, Pilcomayo River, 580 kilometers west of Asuncion, Chaco Paraguayo, Paraguay, collected by Pedro Willim in October, 1946.

Paratypes.—Museum of Comparative Zoology, Nos. 49520-24, with the same data as the type.

Diagnosis.—Apparently most closely related to *Liolaemus wiegmanni* (Duméril and Bibron) from which it differs in having the lateral scales not

smaller than the dorsals, in having the upper labials and infraorbital separated by only a single series of scales, and in coloration.

DESCRIPTION.—(Paratype variations are in parenthesis.) Nostril lateral; upper head scales rather small, keeled or rugose; interorbital scales in 2 (1 or 2) rows; parietals a little larger than interparietal (or sometimes about the same size as interparietal); a series of about 4 (4-6) enlarged supraoculars; a single series of scales between the labials and the infraorbital; temporal scales keeled; anterior border of ear indistinctly denticulated; sides of neck covered with very small scales, and an irregular longitudinal fold present; a short curved antehumeral fold; dorsal scales moderate, rhomboidal, strongly keeled, the keels forming continuous lines, lateral scales about the same size, imbricate, keeled; ventrals a little larger than, or about the same as, the dorsals, roundish, or rhomboidal, smooth; about 54 (49-53) scales around the middle of the body; about 57 (59-63) scales from occiput to rear of hind limb; the adpressed hind limb reaches to the ear; hinder side of thighs with a rather ill-defined patch of enlarged, rhomboidal, keeled scales; 5 anal pores (6-7, and none in two; apparently present in males only as in other members of the genus); caudals as large as, or larger than, dorsals.

COLORATION IN ALCOHOL.—Above, head and body gray; the head variegated with blackish and brownish; on each side of the vertebral line a series of blackish spots, each spot more or less paired with its fellow of the opposite series and each spot becoming closer to its fellow posteriorly until upon the tail they may merge to form crossbands; dorsal spots indistinctly bordered posteriorly with whitish; an indistinct brown, sometimes blackish-edged above, dorsolateral streak beginning near the posterior border of the eye and extending on to the base of the tail; on the flanks, below the streak, are a series of blackish spots whose upper posterior edge is whitish, these spots tending to coalesce, bordered below by an obscure gray streak; limbs brown, cross banded with brownish, blackish, or gray (brownish and blackish); tail brown, marked as mentioned above, regenerated portion uniform grayish-brown. Below, including base of tail, whitish, marked with gray (or sometimes brown) flecks and dashes; rest of tail mostly unmarked except where the dorsal color encroaches, regenerated portion uniform gray.

Three of the paratypes are, above, except for limbs and tail, decidedly more faintly marked. As two of these are the examples without anal pores, apparently these three represent the female and immature coloring.

MEASUREMENTS

	Total Length	Head and Body	Tail	Hind Limb	Hind Foot
Type	110 mm.	45 mm.	65 mm.	32 mm.	16 mm.
Paratype No. 49520	118 mm.	43 mm.	75 mm.	29 mm.	14 mm.
Paratype No. 49524	112 mm.	40 mm.	72 mm.	26 mm.	13 mm.
Remaining paratypes	..	40–45 mm.	..	26–30 mm.	13–14 mm.

The tail of the type is partially regenerated. That of the paratypes, where no measurement is supplied, partially regenerated or incomplete.

MUSEUM OF COMPARATIVE ZOOLOGY, CAMBRIDGE 38, MASSACHUSETTS.

The Relationships of the Garter Snake *Thamnophis ordinoides* [1]

By Wade Fox

THE many instances of range overlap by subspecies of the *ordinoides* Artenkreis as defined by Fitch (1940) have been criticised by several authors. Mayr (1942: 133-134) suggested that the species *Thamnophis ordinoides* be divided into three species. Johnson (1947) followed Mayr's suggestion and split the races *ordinoides* and *atratus* from the *elegans* group. In both cases these decisions were made without personal acquaintance with the intergrading populations and are not justified.

If one examines the chain of races of the *ordinoides* Artenkreis, with the view of locating a break in the chain, the supposed intergradation between *ordinoides* and *atratus* is seen to be questionable. Separation of *ordinoides* from *atratus* as a full species eliminates the same element of range overlap that disturbed Johnson (1947), but maintains *atratus* in proper relationship with *elegans*. Fitch (1940) was acutely aware of the atypical "intergradation" between *ordinoides* and *atratus*, but treated them as subspecies on the basis of the information at his disposal, and because of habitat and geographic relationships that strongly indicated that they might be geographic races. Fitch (1940) and Johnson (1947) clearly describe the absence of intergradation of the subspecies *T. o. ordinoides* with the subspecies *T. o. vagrans*, *T. o. elegans* and *T. o. hydrophila* whose ranges it overlaps.

The following facts were considered by Van Denburgh and Slevin (1918) and Fitch (1940) as additional bases for regarding *ordinoides* and *atratus* as subspecies: they seem to occupy the same ecological niche, especially in the area of overlap; northward there was thought to be a reduction in the average number of ventrals, caudals, and labials in *atratus* that approaches the conditions found in *ordinoides*; Fitch (1940: 92) thinks there is a merging in eye color and shape of head, although there is not a gradual transition of body color pattern between the two forms.

Fitch (*loc. cit.*) suggested a relationship at the species level between these two forms in the following statement: "Possibly these forms represent closely related but distinct species which hybridize in the region where their ranges overlap. For positive determination of their genetic relationships, a large number of gravid females from the region of intergradation should be collected and variation in their broods of young studied."

Area of "Intergradation."—Van Denburgh and Slevin (1918: 223) gave the area of intergradation between *ordinoides* and *atratus* as Del Norte County, California, and admitted some overlap in their ranges. They cited the populations at Requa and Crescent City as showing intergradation between these forms. These populations contained many specimens that were clearly either *atratus* or *ordinoides* but a few were considered to be intermediates. Fitch (*loc. cit.*) found the same situation along the Klamath River and the Smith River in western Del Norte County. Both authors described

[1] A contribution of the Museum of Vertebrate Zoology and the Department of Zoology, University of California, Berkeley, California.

ordinoides as being well set off from *atratus* morphologically and characterized the intergradation between the two as abrupt. Fitch pointed out that typical *atratus* occurs as far north as the Oregon state line and typical *ordinoides* occurs southward to the Klamath River. This is an overlap in range of 33 miles and quite probably this overlap could be extended farther by more thorough collecting. Such an overlap of ranges is not the usual condition found in freely interbreeding geographic races.

Ecological Relationships.—I collected 73 examples of *atratus* and 127 of *ordinoides* in Del Norte County in the spring and summer of 1946 and 1947. I did not detect an ecological segregation of the two types. Both fed on small gray slugs and occurred together in most areas. The form *atratus* was more abundant in the grassy areas along the banks of the Klamath River and *ordinoides* was more abundant beside brush-grown ditches along the roads at Requa. These observations do not clearly indicate a difference in their ecological preferences. However, even if the two occupy essentially the same ecological niche this circumstance does not contradict the possibility of their being different species. In fact, the competition between them may be a limiting factor in preventing further invasion into each other's range.

Size Relationships.—A statistical analysis of gross measurements of all the specimens in my samples would clearly indicate that *atratus* is the larger species. However, at a sacrifice of large numbers, I think a more fundamental size difference can be demonstrated by comparing snakes of the same age class whenever the age can be determined. One method of doing this with a reasonably high degree of accuracy is to compare the smallest size classes of the sexually mature snakes of each species. These groups would presumably be in the first year of maturity. Although individual variation may exist in regard to size or age at maturity, the differences between these two species is pronounced.

From a group of snakes collected at Requa and Crescent City in August, 1947, I was able to segregate the first-year adults in the following manner. Gravid females were, of course, easily recognized. Females that had recently given birth were distinguished by the large corpora lutea present in the ovary and the vascular condition of the oviducts. Of these, the first-year adults could be identified by the lack of characteristic luteal fragments in the ovary from previous years. The mature males could easily be recognized by the distended and coiled vas deferens, enlarged testes, and white appearance of the kidney. Those males that were just entering their first year of maturity had straight, empty vasa deferentia, slightly enlarged testes, and kidneys intermediate in color between the pinkish immature or female type of kidney and the large whitish kidney of the mature male.

Four of the smallest gravid female *ordinoides* (first-year adults) ranged from 308 to 322 mm. in body length. The four smallest gravid female *atratus* ranged from 410 to 452 mm. in body length. The largest immature female *ordinoides* was 306 mm. in body length, but all others were less than 300 mm. Immature female *atratus* in these samples occurred as large as 350 mm. in body length. The larger adult female *ordinoides* ranged from 370 to 390 mm. Adult female *atratus* ranging from 500 to 560 mm. in body length were common.

Two male *ordinoides* that were entering their first year of maturity measured 225 and 226 mm. in body length. One *atratus* at the same stage of development was 308 mm. A male *ordinoides* that appeared to be entering its second year of maturity measured 244 mm., whereas the smallest possible second year *atratus* measured 326 mm. The large adult male *ordinoides* ranged from 340 to 390 mm. Large male *atratus* ranged from 400 to 466 mm. It is obvious, even without measurements, that *atratus* is the larger species, and that this size difference is apparent from birth.

As has been demonstrated for other species of snakes, there is a positive correlation between the size of the female and the number of young in these two forms. Eighteen broods of *ordinoides* born soon after capture ranged from 4 to 8 in number and averaged 6.4 young per brood. Eleven broods of *atratus* ranged from 4 to 14 and averaged 8.6 young per brood. It is difficult to decide whether the difference in number of young between the two species is a specific difference in itself, or merely a result of the larger size attained by *atratus*.

SCUTELLATION.—*Thamnophis ordinoides* and *atratus* usually differ in scale counts, but intermediate specimens that suggested some interbreeding have been reported. The type of variation in scale counts that occurs in the two forms does not necessarily imply interbreeding, but rather could be regarded as normal variation within each discrete population. I have unpublished data showing that scutellation can be altered appreciably by incubation temperatures during development in specimens of *atratus* from a San Francisco peninsula population. Therefore, the frequent reduction of scale numbers in *atratus* from the typical condition may be produced by environmental factors in this cool, fog-covered coastal strip rather than by genetic interrelation.

Even without the knowledge of the effect of temperature on scale numbers it is possible to show by statistical analysis that the two forms dealt with are from two distinct populations.

Typically *atratus* has the dorsal scale formula 19-19-17, whereas *ordinoides* typically has the formula 17-17-15. The following tables show the frequency distribution of scale rows from the specimens taken in Del Norte County.

FREQUENCY OF SCALE ROW COUNTS AT THE NECK

	15	16	17	18	19	20	21
ordinoides	5	2	218		1		
atratus			6	5	145	1	3

FREQUENCY OF SCALE ROW COUNTS AT MIDBODY

	15	16	17	18	19	20	21
ordinoides	7	2	211	3	3		
atratus			6		143	4	7

FREQUENCY OF SCALE ROW COUNTS IN FRONT OF ANUS

	13	14	15	16	17
ordinoides	3	1	222		
atratus			36	7	117

Inspection of these tables shows clearly the marked differences that exist between the two species, without further computations.

Frequency distribution of supralabials and infralabials present a situation comparable to that of number of scale rows.

FREQUENCY OF COUNTS OF SUPRALABIALS

		4	5	6	7	8	9
ordinoides	Left	1	3	11	193	18	
	Right		2	15	184	25	
atratus	Left			5	46	106	1
	Right			4	45	109	

FREQUENCY OF COUNTS OF INFRALABIALS

		5	6	7	8	9	10
ordinoides	Left	1	4	11	155	47	8
	Right	1		12	144	51	8
atratus	Left			1	9	66	81
	Right				10	67	80

Closer correspondence is found in the condition of the preocular and postocular scales.

		PREOCULARS		POSTOCULARS			
		1	2	1	2	3	4
ordinoides	Left	188	38		45	167	
	Right	191	35		35	177	
atratus	Left	152	6	1	28	128	1
	Right	151	7		12	143	3

Chi-square computed as a test of significance of the difference for the preoculars is 23.18. This, of course, implies that it is extremely unlikely that

the two forms of snakes are from the same population. Chi-square for the postoculars is 4.19 which indicates only a slight significant difference in the condition of this character. I am of the opinion that preoculars and postoculars have little diagnostic value in these two snakes. They are very susceptible to temperature fluctuations during development.

Numbers of ventrals and caudals are important in deciding the relationships of these snakes. There is considerable overlap in these characters in *ordinoides* and *atratus*, a condition that has been considered to be evidence of intergradation. The large series of specimens now available shows a great significant difference between the two in both ventral and caudal counts. For both characters the sexes are compared separately in the following table. An idea of the order of the difference between the two forms is given by the fact that the male *ordinoides* average very nearly the same as the female *atratus* in number of caudals.

Ventrals	Number	Range	Mean	Standard Deviation	Coefficient of Variation	Standard Error of Difference between Means
Males						
ordinoides	110	138-160	147.40±.46	4.83	3.28	
						.65
atratus	91	151-175	162.18±.46	4.43	2.73	
Females						
ordinoides	128	134-159	144.93±.42	4.77	3.29	
						.73
atratus	70	148-170	159.19±.59	4.93	3.10	
Caudals						
Males						
ordinoides	91	61-82	72.12±.44	4.15	5.75	
						.62
atratus	80	71-90	82.10±.45	4.06	4.95	
Females						
ordinoides	121	55-72	63.63±.30	3.30	5.19	
						.55
atratus	58	65-82	72.71±.46	3.53	4.85	

All the data presented in the forgoing tables are from the combined samples from Requa, Klamath, Crescent City, and Smith River as well as the broods of young that were born in captivity soon after capture of the gravid females. In addition to an analysis of the combined data, the samples from Requa and Klamath, where the largest number of specimens were taken, were statistically analyzed and found to yield essentially the same results as did the whole group.

Color and Color Pattern.—Coloration was not considered by Fitch (1940) strongly to indicate intergradation. This is primarily because *atratus* can always be recognized by its broad yellow dorsal stripe (associated with the high scale counts) whereas most specimens of *ordinoides* have red dorsal stripes (associated with low scale counts), at least in the area under consideration. After collecting a large number of snakes and examining several broods of both species, I realized that every specimen could be identified on the basis of color alone. Recognition of the great amount of variation that occurs in *ordinoides* within a very limited population and also of the re-

markable uniformity in *atratus* is necessary in order properly to identify the species. These color differences must be learned for each population because both species show considerable variation over relatively short distances. For example: *atratus* at Crescent City has a tendency toward increased amount of red in the dorsal stripe and lacks the small light spots between the middorsal scale rows; both of these characters are opposed to the condition found in *atratus* at Requa and Klamath but constitute a resemblance to *ordinoides* from the latter localities. In other characters, however, Crescent City *atratus* is even more distinct from *ordinoides* than is the Requa *atratus* and there is no difficulty in segregating them. At Crescent City there appears to be even less indication of intergradation.

At Requa and Klamath all specimens of *atratus* possess a pronounced yellow stripe that uniformly occupies the middorsal scale row and one-half row on each side. At the nape of the neck the dorsal stripe spreads out for a few scale's width to occupy three scale rows in most individuals. There is only minor variation of this character. The color of the dorsal stripe varies slightly and individuals may be described as having Chamois[2] or Reed Yellow stripes. In *ordinoides* from the same localities the color of the dorsal stripe varies extremely. The red color that is present in the dorsal stripe of about 70 per cent of the adults is a Brazil Red. It differs from the Grenadine Red spots on the ventral surface. Red pigment is not apparent in the newly born snakes. In the adults it varies from complete absence to a broad dorsal stripe. The late appearance of the red stripe and its variation in the adults indicate that it is independent of the less conspicuous dorsal stripe that is present in the young and throughout life unless hidden by the red. This dorsal stripe occupies only the middorsal scale row, though a lightening of the edges of the adjacent rows gives it a broader appearance in some individuals (Fig. 1). Certain specimens can be described as having Dull Citron, Olive Lake, or Saccardo's Olive dorsal stripes. Considerable variation in the color of this stripe is present. In a few specimens it can barely be distinguished from the background color. It is never as broad nor as bright as in *atratus*. At the nape of the neck the dorsal stripe is usually limited to one scale row but occasionally parts of the two adjacent rows are involved. Sometimes the middorsal row of scales drops out on the nape and the two adjacent rows occupy a symmetrical position on the mid-line, both of which may be light-colored. In a few specimens the dorsal stripe on the nape is brighter colored and similar to the color of the stripe in *atratus*.

The ground color between the dorsal stripe and the lateral stripes is remarkably uniform in *atratus*. Most individuals appear Dark Olive-Gray to Mouse Gray. The color of the dorsolateral regions in *ordinoides* only rarely resembles that of *atratus* and then the similarity is due to a dulling of the normal color by the loosening of the skin prior to shedding. Deep Olive, Olive Brown, Deep Grayish-Olive, and Saccardo's Olive are a few of the shades that can be recognized, but this list by no means takes in all of the variation that occurs in the ground color of *ordinoides*.

Small Scarlet spots appear in the dorsolateral and lateral regions of *atra-*

[2] Ridgway nomenclature.

tus. A few such spots occur in the dorsal stripe. The sparse ventral spots in *atratus* are approximately Bittersweet Orange.

Two rows of dark blotches along each dorsolateral region are characteristic of the color pattern of *atratus*. These are fairly distinct in young snakes, but rather indistinct among the adults. Each blotch usually occupies portions of four or more scales (Fig. 1). Most individuals of *atratus* have both rows of blotches very well-developed. A few have interruptions in the lower row but the upper row does not seem to be as variable. A suggestion of these two rows of blotches is present in *ordinoides*. Some specimens have only traces of them, whereas others may have a fairly well-developed lower row. None of the specimens of *ordinoides* examined had a well-developed upper row of blotches (Fig. 1). Interference with the rows of blotches seems at least partially to be associated with the loss of scale rows.

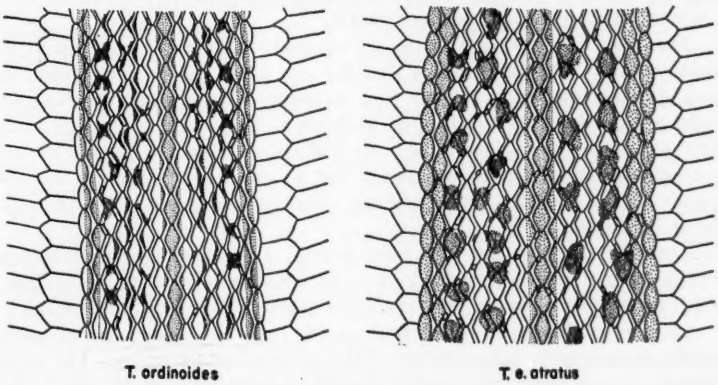


Fig. 1. Flattened, stretched skins of *Thamnophis elegans atratus* and *T. ordinoides* to show interscale light spots, lateral blotches, and width of middorsal stripe.

A constant feature of the color pattern in *atratus* at Requa and Klamath is the presence of irregular light spots between the dorsal scales. These spots occur between every row of scales. They are largest laterally and become gradually smaller medially (Fig. 1). Between the middorsal scale row and the two adjacent rows these spots may be smaller than a pin head, but sometimes they are larger. The color of these spots in *atratus* is a Yellow Glaucous. In *ordinoides* from the same localities I found only one specimen that had these spots between the middorsal and adjacent rows. All examples of *ordinoides* examined have large White spots between the lateral scale rows and very small or no spots between the dorsolateral rows (Fig. 1). The small White interscale spots are frequently continuous with larger Pale Viridine Yellow spots on the upper edges of the scales.

Lateral stripes are always distinct and uniform in color in *atratus*. In *ordinoides* they vary from absent to conspicuous. In about 40 per cent of the specimens of *ordinoides* from Requa the lateral stripe is absent or very weakly differentiated.

I have not been able to segregate these two species successfully on the basis of eye color.

EXAMINATION OF BROODS.—I have examined 35 broods of snakes from the area of supposed intergradation. These broods were born in captivity within one to fourteen days after capture of the gravid females and thus would probably be normal in scale characters and color pattern, as these characters are determined too early in development to be altered so near the time of parturition. Twenty-two of the broods are *ordinoides*, 13 are *atratus*. In each brood all the young are clearly of the same species as the mother. There is no indication of interbreeding in any of these broods. The *atratus* broods show remarkable uniformity of color pattern and are typical *atratus*. There is considerable variation of color and pattern in each brood of *ordinoides*, but it is essentially the same as described earlier. Although the shape of the head of adults is not consistently different in the two species, it appears distinct in the new-born snakes.

The lack of indication of interbreeding resulting from the examination of broods is only negative evidence that the two forms do not interbreed. It does not eliminate the possibility that occasional breeding between the two could occur. However, the lack of evidence of interbreeding and the clear segregation that many important scale and color characters display in the two sympatric types leaves little doubt that we are dealing with two distinct species. There does not seem to be any conclusive indication even of occasional hybridizaton.

That these two species were once part of a continuously interbreeding population that became separated into a northern and a southern population, which have now renewed contact, as Fitch (1940: 92) implied, is probable.

In view of the evidence presented in this paper it is necessary to make certain changes in the nomenclature of this group of garter snakes. The races *elegans, atratus, biscutatus, hueyi, vagrans, hydrophila, couchii,* and *gigas* are classified as subspecies of *Thamnophis elegans,* while *Thamnophis ordinoides* is considered to be a monotypic species.

LITERATURE CITED

FITCH, H. S.
1940 A biogeographical study of the Ordinoides Artenkreis of garter snakes (genus *Thamnophis*). *Univ. Calif. Publ. Zool.*, 44: 1–150.

JOHNSON, M. L.
1947 The status of the *elegans* subspecies of *Thamnophis*, with description of a new subspecies from Washington State. *Herpetologica*, 3: 159-165.

MAYR, ERNST
1942 Systematics and the origin of species. New York, Columbia University Press: xiv + 334 pp.

VAN DENBURGH, JOHN, and J. R. SLEVIN
1918 The garter snakes of western North America. *Proc. Calif. Acad. Sci.*, (4) 8: 181-270.

UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA.

Further Remarks Concerning *Thamnophis ordinoides* and Its Relatives

By Henry S. Fitch

SINCE publication of my revision of the *ordinoides* Artenkreis of garter snakes (Fitch, 1940), various authors have dealt with the same group or parts of it, presenting new information, or different conclusions. It is the purpose of the present paper to discuss critically these reports, and to re-examine the entire group in the light of them.

To review briefly the conclusions of my revision, the eleven forms were divided into three series, the central *elegans* group, *vagrans-biscutatus-elegans-hueyi,* conservative in most respects, the aquatic *hydrophila* group, *hydrophila-couchii-gigas-hammondii-digueti,* showing progressive adaptive specialization, and lastly the *ordinoides* group, *atratus-ordinoides,* diverging as a terrestrial-secretive offshoot of *elegans.* The forms *hammondii* and *digueti* were considered to be distinct species as their ranges were apparently separated from those of the most closely related forms. The remaining nine forms were considered to comprise a single polytypic species, or Rassenkreis.

The subspecies *vagrans* was identified as the probable ancestral form of the entire complex. Its extensive range in the Rocky Mountains and Great Basin much exceeds the combined ranges of the other ten. In habits, color pattern, scutellation and body proportions it is intermediate and unspecialized. In the Sierra Nevada it merges into the more terrestrial *elegans,* which differs in darker ground color, brighter dorsal stripe and tendency toward reduction of scale rows from 21 to 19. Subspecies *hueyi,* of the San Pedro Martir range in northern Lower California, is essentially similar to *elegans* but with paler ground color, smaller size and reduced numbers of ventrals. *Thamnophis elegans biscutatus,* of the Klamath Lake region, differs from *vagrans* in more aquatic habits, larger size, frequent increase of scale rows to 23, more numerous ventrals, brighter stripes, and darker ground color. It is annectant and possibly ancestral (through *hydrophila*) to the entire *hydrophila* group, characterized by suppression and final loss of the stripes, elongate and pointed head shape, and other specializations for aquatic life. *Thamnophis elegans hydrophila,* of southwestern Oregon and northwestern California, is the smallest of this group, and it retains the dorsal and lateral stripes and tends to have the scale rows reduced to 19. *Thamnophis elegans couchii* of the Sierra Nevada has checkered pattern, with dorsal stripe much reduced. The subspecies *gigas* of the San Joaquin Valley is characterized by especially large size, 23 scale rows, and dull brownish-colored pattern. In *hammondii* of southwestern California the dorsal stripe is almost suppressed, eyes are unusually large, and dorsolateral markings reduced. In *digueti* both dorsal and lateral stripes are entirely lacking, dorsolateral spots are suppressed, and ventrals are reduced in numbers.

In the *ordinoides* group there is reduction in scale rows to 19 in *atratus* and to 17 in *ordinoides,* and there is comparable reduction in size, and in numbers of ventrals, and labials. Bright stripes and contrasting patterns are retained with the tendency to develop red in the color pattern either ventrally,

dorsolaterally, or in the lateral or dorsal stripes. These two forms are adapted to terrestrial life in meadows, along streamsides, or in clearings of damp forests. *Thamnophis ordinoides* is the more specialized, while *atratus* is annectant to *elegans*, which it closely resembles.

Concurrently with divergence in habitats and feeding habits, overlapping in geographic ranges has occurred so that some of the more dissimilar races coexist over wide areas. Thus *vagrans* overlaps *ordinoides* and *couchii*; *elegans* overlaps *ordinoides, hydrophila, couchii* and *hammondii*; *hueyi* overlaps *hammondii*; *atratus* overlaps *hydrophila* and *hammondii*; and *hydrophila* overlaps *ordinoides*.

Geographic Ranges.—Stejneger and Barbour (1943: 167-170), concurring with my general concept of the group, correctly stated the ranges of the forms *digueti, ordinoides, atratus, couchii, elegans, gigas, hammondii,* and *hueyi*. But the range of the race *hydrophila*, given as "Streams of the Rogue River Basin, Oregon," is actually much more extensive, from the Umpqua River on the north to the San Francisco Bay region on the south. For the race *biscutatus* the same authors stated the range to be: "Southern British Columbia Vancouver Island, to Siskiyou and Modoc counties, California." Actually *biscutatus* is limited to the region of the Klamath lakes basin of northeastern California and southern Oregon. The inclusion of southern British Columbia was based upon records of the closely related *vagrans*.

Newly Described Forms.—Smith (1942: 112) described *Thamnophis ordinoides errans* from 6 Mexican specimens collected at Colonia Garcia, Chihuahua, and Coyotes, Durango, localities remote from the previously known range of the group. As stated by Smith, the relationships and phylogenetic position of *errans* are not clear. The forms *ordinoides, atratus,* and *hydrophila,* with which it is compared in the description, are so remote in terms of distance and physiographic barriers that intergradation with any of them is out of the question. Relationship of *errans* to the *ordinoides* complex, if demonstrable, may logically be sought through *vagrans*. The latter, though well separated from it geographically, is much less remote than the remaining forms. Also, in general coloration, shape of head, and proportions of head shields, there is resemblance. But *errans* has only 19 scale rows while *vagrans* has 21 (occasionally 23); *errans* has fewer maxillary teeth, and its ventrals average fewer, with but little overlapping. In view of these and other minor differences, and the well separated ranges, it seems evident that the form in question should be accorded rank as a distinct species, *Thamnophis errans,* though with probable affinities to the *ordinoides* complex through *vagrans*.

Johnson (1947: 161) has recently described a population occurring in western Washington and British Columbia as *Thamnophis elegans nigrescens,* separated from *vagrans* on the basis of darker coloration, and fewer ventrals and caudals. In the past this population has frequently been included with *biscutatus* (Van Denburgh, 1922: 838; Stejneger and Barbour, 1944:170) partly on the basis of its frequently divided preoculars (a character not mentioned by Johnson). Actually it is distinct and geographically remote from *biscutatus* but is only weakly differentiated from the parent population of *vagrans*. In my original revision (Fitch, 1940: 20), after reviewing the

characters of this population, including, in addition to those already mentioned, a tendency toward narrowness of the head and bluntness of the snout and reduction in length of the fifth scale row, I concluded: "The humid coastal area occupied by this population is faunally distinct from the rest of the range occupied by the subspecies *vagrans*. However, the incipient racial differentiation does not seem to me great enough to warrant its separation as a subspecies distinct from *vagrans*." In rejecting this decision Johnson presented only meager supporting evidence. Examining the characters used by him we find that the ventrals in a series of 29 *nigrescens* from British Columbia and western Washington averaged almost exactly the same for each sex as in a series of 28 *vagrans* from the southern end of the range, Arizona and New Mexico (*Ibid.*: 11, fig. 3), and that although *vagrans* shows much variation over its wide range in this character, series from all parts of the range overlap *nigrescens* widely. In caudals *vagrans* over its range as a whole varies somewhat less than it does in ventrals, and *nigrescens* is a little more distinct, but overlaps all series. A series of 21 *nigrescens* is only slightly exceeded in numbers of caudals by, for instance, the series of 29 *vagrans* from Montana, and Wyoming (*Ibid.*: 12, fig. 4). The increased pigmentation is perhaps more significant than these slight differences in scale counts; the latter may well be of ontogenetic origin under the influence of the different climatic conditions. But the sum total of differences seems small in view of the variability of this and the other subspecies. With the exceptions of the geographically localized *hueyi, biscutatus,* and *gigas,* all the subspecies have "sub-races" fully as well differentiated as is *nigrescens* from *vagrans*. Unless general acceptance of all such minor geographic entities as subspecies is adopted, I regard it as inconsistent to recognize *nigrescens*.

Relationships of Forms.—Although *hammondii* was allocated as a typical member of the *hydrophila* group within the *ordinoides* complex, it was also considered to be a distinct species (Fitch, *op. cit.*: 73) on the ground that satisfactory evidence of intergradation with other forms was lacking. The dry mountain ranges of the Tehachapi region were thought to constitute a barrier between it and the most closely related form, *couchii,* for, ". . . although partial intergradation occurs, it is not comparable to the continuous, gradual, and complete transition in characters which takes place between other intergrading forms of *ordinoides*" (*Ibid.*: 67). Later experience with *couchii,* in the dry foothill region east of Madera, California, indicated an unexpected tolerance for drought conditions, as the snakes occurred regularly and abundantly along streams that dried in early summer. In view of its occurrence in such situations, a distribution throughout the higher ranges of the Tehachapi region seems probable, as numerous small creeks in that region appear capable of supporting permanent populations. This is the area between the known ranges of *couchii* and *hammondii* from which material is not yet available. In May, 1947, two specimens were taken in Tehachapi Creek south of any previous localities of collection for *couchii*. The head markings in these resemble *hammondii* more than do any other *couchii* examined, but in numbers of ventrals they resemble typical *couchii*. In view of the partial intergradation demonstrable and the probable occurrence of

further intermediate populations, it now seems best to relegate *hammondii* to the status of a subspecies.

There are no valid grounds for relegating *digueti* to subspecific status. Although it is obviously a derivative of *hammondii* or a *hammondii*-like common ancestor, its range is separated from that of *hammondii* by some 300 miles of uninhabitable desert. To mention the more trenchant characters, the absence of parietal spots and of lateral stripes, both well developed in *hammondii*, and the suppression of the dorsolateral spots, provide differences by which every specimen of the two forms can be separated. That *digueti* is a geographic representative of *hammondii*, and that they once formed a continuously interbreeding population seems highly probable. But at present they do not intergrade even by overlapping of characters, and it cannot be stated positively that they would still interbreed if their ranges were contiguous. As a somewhat parallel example, *atratus* and *ordinoides*, closely similar and replacing each other geographically, have always been classed as subspecies, but recent findings by Fox (1948: 120) indicate that they actually overlap slightly in ranges without intergradation. Such situations illustrate the benefit of the objective criterion, intergradation, for determining whether any form is a subspecies or a distinct species. Many systematists still adhere to this criterion. Other authorities, as exemplified by Dr. Ernst Mayr, extend the polytypic species concept to include as conspecific closely related forms that represent each other geographically, even though they may occupy well separated ranges and may be so well differentiated that they do not overlap (through individual variation) in many of their characters.

Mayr (1941: 115, and 1942: 133) has criticized my arrangement of forms in the *ordinoides* complex, objecting to the inclusion as subspecies in the same species of those forms having wide geographic overlap. He states that "strict adherence to the intergradation principle led to an absurd nomenclature." On the basis of data set forth in my revision (but apparently with no first hand knowledge of these snakes) he states that the complex should be divided into three separate species corresponding to the three ecologic groups, each with a series of forms, namely the *elegans*, *hydrophila*, and *ordinoides* groups. This arrangement has also been advocated by Johnson (1947), likewise with no first hand knowledge of the group in the critical areas involved in such a division.

Mayr states that the forms that belong to each of the three groups constitute morphological and biological units. This is hardly correct. The three groups are artificial in their limits, and the names were established to emphasize ecological trends. The *ordinoides* group is terrestrial, the *hydrophila* group is aquatic, while the four closely related forms of the *elegans* group include, besides the ecologically unspecialized *vagrans*, a rather aquatic form (*biscutatus*) and two forms (*elegans* and *hueyi*) often found in dry-terrestrial habitat. The transition between the *elegans* and *hydrophila* groups, through the *biscutatus-hydrophila* contact, and between the *elegans* and *ordinoides* groups through the *elegans-atratus* contact are thus between races similar both morphologically and ecologically. While more material from the intermediate areas is perhaps desirable, there is every indication that intergrada-

tion in these instances is complete and of the gliding type. Yet Mayr characterizes each of these as a "hybrid population," thus implying that there is not freedom of interbreeding, or that these are somehow different from populations of ordinary intergrades. Drs. Mayr and Johnson would no doubt be hard put to draw the dividing lines if confronted with existing intergrading series, from *atratus* or *elegans* at the one extreme to *hammondii* at the other. The idea that lines of specific demarcation should be drawn arbitrarily through intergrading populations, either because end forms overlap or because ecologic divergence occurs, is utterly untenable.

In Dr. Mayr's excellent book "Systematics and the Origin of Species" (1942) I find the remarks concerning these garter snakes somewhat inconsistent with other material. Citing several examples in species of birds and mammals, Mayr states:

> The perfect demonstration of speciation is presented by the situation in which a chain of intergrading subspecies forms a loop or an overlapping circle, of which the terminal forms no longer interbreed, even though they coexist in the same localities. . . . The puzzled systematist who comes across such cases is tempted to 'simplify' them by making two species out of one ring, without frankly telling the facts. Overlapping rings are disturbing to the orderly mind of the cataloguing systematist but they are welcome to the student of speciation.

He cites as an example that the ranges of *Peromyscus maniculatus artemisiae* and *P. m. osgoodi* overlap extensively in the Glacier National Park region of Montana with no evidence of interbreeding, although both forms intergrade with the races *arcticus* and *sonoriensis*. It has recently been demonstrated that in northern Michigan, two other races of the same species, *P. m. gracilis* and *P. m. bairdii*, overlap each other extensively (Hooper, 1942). Mayr records two similar cases in different species of the Old World warblers, *Phylloscopus* in central Asia, and another for the tit, *Parus major*, in the Amur Valley. These species all parallel the situation in the garter snakes, which differs only in the relatively larger areas of overlap.

In my revision, a weak link in the demonstrated chain of intergradation was recognized in the relationship of *ordinoides* and *atratus*. As intimated above, Fox (1948: 113–20) has brought forth evidence to prove conclusively that *ordinoides* and *atratus* are specifically distinct. His intensive field work in the area where the two forms meet served to show the range of individual variation in each of them, the extreme localization of minor geographic variants, and the segregation of *atratus* and *ordinoides* characters in different individuals. Finally, in a large number of broods of each type, all young resembled their mothers, and showed no indication of interbreeding between the two forms. The separation of *ordinoides* from the remainder of the Rassenkreis on the basis of Fox's findings necessitates nomenclatural changes for most of the other forms. The species and subspecies now recognizable are listed below:

Thamnophis elegans elegans (Baird and Girard)
Thamnophis elegans vagrans (Baird and Girard)
Thamnophis elegans biscutatus (Cope)
Thamnophis elegans hueyi Van Denburgh and Slevin
Thamnophis elegans hydrophila Fitch

Thamnophis elegans couchii (Kennicott)
Thamnophis elegans gigas Fitch
Thamnophis elegans hammondii (Kennicott)
Thamnophis elegans atratus (Kennicott)
Thamnophis ordinoides (Baird and Girard)
Thamnophis errans Smith
Thamnophis digueti (Mocquard)

Within this group, every stage in the process of speciation is exemplified, from the incipient, barely measurable differentiation of neighboring populations within the same race, through subspecific differentiation of varying degrees, culminating in forms whose connecting link with the parent stock is broken. The frequent existence of partly sympatric subspecies still connected by geographic intergradation is a peculiarity of this group of snakes. This phenomenon, rare in vertebrate species, and perhaps nowhere else so far developed, apparently arises from the fact that the group as a whole is vacillating between a terrestrial and a partly aquatic mode of life. As a result, closely related forms diverge so widely in habits and ecologic niches that such overlapping can occur without much competition.

Literature Cited

Fitch, Henry S.
1940 A biogeographical study of the Ordinoides Artenkreis of garter snakes (genus *Thamnophis*). *Univ. Calif. Publ. Zool.*, 44: 1–150.

Fox, Wade
1948 The relationships of the garter snake *Thamnophis ordinoides*. Copeia, 1948: 113–120.

Hooper, Emmet T.
1942 An effect on the *Peromyscus maniculatus* rassenkreis of land utilization in Michigan. *Jour. Mamm.*, 23: 193-196.

Johnson, Murray L.
1947 The status of the *elegans* subspecies of *Thamnophis*, with description of a new subspecies from Washington State. *Herpetologica*, 3: 159-165.

Mayr, Ernst
1941 What is an artenkreis? Copeia, 1941: 115-116.
1942 Systematics and the origin of species. New York Columbia University Press: xiv + 334 pp.

Smith, Hobart M.
1942 The synonomy of the garter snakes (*Thamnophis*), with notes on Mexican and Central American species. *Zoologica*, 27: 97–123.

Stejneger, Leonhard, and Thomas Barbour
1943 A check list of North American amphibians and reptiles. Fifth edition. *Bull. Mus. Comp. Zool.*, 93: xix + 260 pp.

Van Denburgh, John
1922 The reptiles of western North America. *Occ. Pap. Calif. Acad. Sci.*, (10) 2 vols.: 1–1028.

U. S. Fish and Wildlife Service, Leesville, Louisiana.

Marking Reptiles with an Electric Tattooing Outfit

By Angus M. Woodbury

SINCE 1939, I have been experimenting with the marking of snakes for individual identification by placing tattooed numbers under the skin in such a way that moulting of the skin would not obliterate the marks. During that time, 777 Great Basin rattlesnakes, *Crotalus viridis lutosus*; 471 western striped racers, *Masticophis taeniatus taeniatus*; 41 western blue racers, *Coluber constrictor mormon*; and 17 Great Basin gopher snakes, *Pituophis catenifer deserticola,* have been numbered by this method.

Many of the rattlesnakes and striped racers have been recaptured in the wild from time to time, some of them several times. Of the blue racers and gopher snakes, in which the numbers of individuals involved were so small, only one recapture has been made. Some of the marks made in the early part of the experiments have been difficult to read, but among the later marks there have been almost no failures.

The tattooing outfit, made to carry in the field, was constructed with the aid of Lamont C. Cole from the following materials: a door bell vibrator coil, to which was attached a short piece of piano wire with six small needles soldered around one end and so arranged that the vibrator moved the wire back and forth in the outside cover of a mechanical pencil. It was adjusted so that the needles protruded from the pencil about 2 mm. when in action. The vibrator was driven at first by four dry cell batteries, but later the number was increased to eight to give it more driving power.

The current from the battery was regulated by a switch so arranged on the pencil that it could be closed when the pencil was grasped and opened when compression was relaxed. In practice, a snake was held in one hand and the tatooing pencil in the other. In order to secure the snake so it could be held in the hand, its head was securely fastened in a leather loop on the end of two sliding sticks. This was held by an assistant when available or placed on the ground under my foot when alone.

In use, the pencil was dipped in a carbon (India) ink, then placed in position and the vibrator started by closing the switch on the pencil with the finger. By pressing the pencil against the skin of the snake and moving the pencil around in the desired direction, figures could be made. The needles carried ink through the skin and left some of it deposited underneath. When heavy scales were encountered, it was necessary to drill through them and leave ink below. It was these heavy scales that required the current from the extra batteries to drill through them. It also became necessary to supplement the vibrator with an extra spring to extract the needles from the scales.

The procedure usually left a smear of black ink on the surface of the skin, which, if removed by a damp cloth, usually revealed the punctures in the skin so that the pattern of the figures could be discerned and supplemental punctures made if necessary. It was found mandatory in making the figures to make extra long strokes on the ends of nearly all the figures in order to distinguish between such figures as 2, 3, 5, 6, 8 and 9.

By the time of the next moult, the punctures of the skin are usually healed and all surplus ink on the surface of the skin is removed. The ink

under the skin is much fainter but under favorable light, the figures can usually be read. Experiments were made with several colors of inks but all were discarded in favor of the black. When numbers were placed on young snakes, the dots left at each puncture gradually separated as growth proceeded and produced a fainter number.

Such numbers do not show very well on pigmented surfaces. The ink is difficult to distinguish from the pigment. To produce satisfactory results, it is necessary to have a clear plain surface. In the racers and gopher snakes the numbers were placed under the base of the tail but this position proved to be unsatisfactory in the rattlesnakes and they were numbered on the ventral side, a few inches back from the head.

This required a special technique, since the soft underside had so little resistance that it was difficult to drill through the scales. There was danger of drilling through the skin into vital organs, from which some deaths resulted during experimentation. However, it was found that it could be accomplished easily and safely by pulling the ventral skin around onto the side and drilling against the ribs.

This method has proved to be a useful and practical way of marking snakes on a large scale for individual identification. Its accuracy is further insured against mis-reading numbers if there is recorded with the numbers such supplemental data as the scale count of the tail plates, which can be checked when recaptured. The writer prefers this method to that of scale clipping, largely because of the difficulty of establishing a satisfactory base from which to count to the scales that are clipped and the consequent uncertainty in individual identification.

It is believed that this tattooing method could be used satisfactorily with lizards, amphibians and fishes. A. Gandolfi-Hornyold (1929) reported marking six silver eels on the light ventral side with India ink by means of a bundle of needles in the oriental fashion. He found the marks clearly legible on five that were still alive six weeks later.

Further experiments in marking fish by the same method were reported by Hickling (1945) in which identification marks were tattooed on plaice, soles and rays kept in tanks. The identification letter and number were easily applied to the soft skinned plaice and soles but the rays had tougher skin that was difficult to penetrate with the needles and the process was less successful with them. Doubtless his tattooing outfit did not have sufficient driving power properly to penetrate the tough skin. After seven weeks (August 4 to September 26, 1939), the markings on three out of ten plaice could be clearly read but three others were faint and four were so faint they could scarcely be discerned.

Literature Cited

Gandolfi-Hornyold, A.

1929 Une nouvelle methode pour marquer des Anguilles; le tatouage. *Bull. Soc. Aquic. et Peche, Paris,* 26: 53–54.

Hickling, C. F.

1945 Marking fish with the electric tattooing needle. *Journ. Marine Biol. Assoc. United Kingdom,* 26: 166–169.

Department of Biology, University of Utah, Salt Lake City, Utah.

Herpetological Notes

EGGS OF *DESMOGNATHUS AENEUS*.—A female of *Desmognathus aeneus* Brown and Bishop, 46.5 mm. long, collected at the type locality by the writers on April 8, 1947, was shipped alive to Professor James R. Slater at the College of Puget Sound, Tacoma, Washington, during the last week in May, 1947. Shortly after arrival the female deposited 15 eggs in a compact cluster, like a bunch of grapes, in the moist moss of the small glass container in which she was shipped.

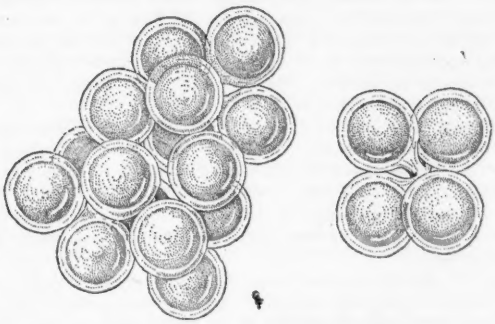


Fig. 1. Egg cluster of *Desmognathus aeneus*, with four eggs removed to show attachment by outer envelope, x 4.

The eggs were pale, creamy white and each surrounded by two envelopes of nearly equal thickness. After preservation the eggs with their envelopes have an average diameter of 3 mm., the yolk about 2.7 mm.

Professor Slater described the female as lying with her head beneath and in contact with the egg cluster.—WALTER C. BROWN and SHERMAN C. BISHOP, *Department of Zoology, University of Rochester, Rochester, New York.*

NOTES ON A LARGE SPECIMEN OF *PHRYNOSOMA SOLARE* GRAY.—During the Chicago Academy of Sciences' 1946 Arizona expedition, D. B. Carver, of Phoenix, presented the collection with a specimen of *Phrynosoma solare* Gray that is apparently larger than any previously recorded. This individual, from Phoenix, Maricopa County, Arizona, has a snout-vent length of 114 mm., and a tail length of 43 mm. (incomplete). Smith (1946, Handbook of lizards: 316) notes the maximum snout-vent measurement of this species as 103 mm.

The specimen, a female, was dissected and found to be in early gestation. Each ovary is about 14 mm. in length, 7 mm. in diameter, and each contains numerous small white eggs of various sizes, the largest of which measures between 3 and 4 mm. Bogert and Oliver (1945, Bull. Amer. Mus. Nat. Hist., 83: 347) record specimens containing from 7 to 21 eggs.

The stomach, large and small intestines, and rectum of this specimen contain the partially digested remains of ants (which it took rather readily before preservation), and the stomach, particularly the cardiac end, was found to be distended by large numbers of nematodes.

I am indebted to Dr. Howard K. Gloyd for the specimen, now number 504 in my personal collection, and for permission to publish this note.—RICHARD A. EDGREN, JR., *Northwestern University, Evanston, Illinois.*

NOTES ON THE BREEDING HABITS OF THE TURTLE *KINOSTERNON S. SUBRUBRUM*.—While collecting near Marietta, Cobb County, Georgia, on May 1, 1934, a copulating pair of the common mud turtle, *Kinosternon s. subrubrum* Lacépède, was encountered near the edge of an open cattail bog. Although another *Kinosternon*, a male, was taking a considerable interest in them he made no effort to interfere. The water was less than 1 inch deep and the clay bottom quite firm at the breeding site. The female walked along slowly during the process and the trio moved some 10 feet during the observation period of approximately 20 minutes.

On June 18, 1935, two individuals containing two eggs each were captured near Marietta. The egg shells in both instances were almost completed. On May 25, 1940, Mr. T. J. Gleaton, Alabama State Trapper, discovered the nest of a mud turtle while setting muskrat traps on a lake near Marion, Perry County, Alabama. This nest contained two eggs deposited in a depression on the floor of an abandoned runway of the muskrat (*Ondatra z. zibethica*). The entrance to the burrow was completely submerged but the turtle nest was about a foot from the water's edge and some 3 inches higher than the normal water level. The eggs were almost completely hidden by sticks and debris which had been placed over them.

Two more nests were discovered by Mr. Gleaton in abandoned muskrat burrows near Opelika, Lee County, Alabama, on June 10, 1940. Each contained two eggs laid on the wet ground of the tunnel and covered with debris. The underwater entrances prevented most, if not all, light from reaching the nests.

A female *Kinosternon* was taken near Opelika, Alabama, in a live trap set at the entrance of an active muskrat burrow. When dissected she was found to contain two completely formed eggs.

It appears that the common mud turtle frequently nests in muskrat tunnels. Since muskrats are known to take other species of turtles as well as their eggs, it would seem unlikely that one could nest successfully in an active muskrat den. The absence of *Kinosternon* remains in the muskrat middens examined is accordingly difficult to explain. —FREDERICK S. BARKALOW, JR., *Department of Zoology and Entomology, N. C. State College of Agriculture and Engineering, Raleigh, North Carolina.*

ODOR OF YOUNG BOX TURTLES.—Nowhere in recent literature have I found reference to the fact that very young examples of the common box turtle, *Terrapene c. carolina* (Linnaeus) are capable of emitting a powerful odor when disturbed. It is not surprising that this habit has been generally overlooked, for juvenile box turtles are seldom collected, even in areas where the species may be abundant.

The box turtle is remarkably abundant a few miles northwest of Augusta, Richmond County, Georgia, 50 or more specimens sometimes being encountered in a day's collecting. Juvenile examples with large, unhealed umbilical scars are found each November, usually in the debris beneath rotting logs in moist woods. Most young turtles are almost concealed in the pulpy medium, only the vertebral bosses protruding. When grasped, the little reptiles emit a stench fully equalling or even exceeding the best efforts of an adult musk turtle. The odors of *Sternotherus odoratus* and of juvenile *T. c. carolina* seem to me almost identical, although the little box turtle is proportionately much the "stronger" animal.

This habit was observed only in box turtles with a carapace length of 30 to 40 mm. (straight measurement); specimens of 50 mm. or more have not been noted to give off any odor. Apparently the ability is lost at about the same time that the plastral hinge becomes functional. Thus very small examples, incapable of completely closing the shell, are protected in another fashion. It is not clear why the ability should soon be lost.

The odors of these and other reptiles are usually considered to serve some protective function. It would be interesting to know whether or not this is true, and if true, how the odor protects, and from what enemies. It seems unlikely that many predators would be discouraged by a mere stench, as such.—WILFRED T. NEILL, *Department of Biology, Augusta Junior College, Augusta, Georgia.*

NORTHWARD OCCURRENCE OF THE CANYON TREE-TOAD IN CALIFORNIA.—The northernmost record of occurrence in California of the canyon tree-toad, *Hyla arenicolor* Cope, has been the Sespe Creek drainage in northern Ventura County. Recent discovery of this amphibian 3½ miles east and ½ mile north of McChesney Mountain, in central San Luis Obispo County, extends the range nearly 100 miles to the north.

Two individuals were found on September 5, 1947, about 8:30 A.M., in shallow water at the edge of a pool in the bottom of a ravine, elevation 1900 feet. The surrounding hills were rocky, covered on north- and west-facing slopes with a heavy growth of manzanita, scrub oak, and chamise, *Eriodictyon* predominating in burned-over areas. Sycamores, junipers, and a few oaks were present in the canyons, the bottoms of which were steep-sided and with little or no loose soil. The exposed rock was a well cemented conglomerate.

The canyon bottoms were of bare rock strewn with gravel and boulders measuring up to 12 feet in diameter. There were few actually sandy portions. At this season small pools were found at intervals of a few hundred yards.

The pond in which the tree-toads were found was at the bottom of a vertical-sided cleft running approximately north and south. The pool was roughly L-shaped, about 25 feet in length, 12 feet in greatest width, and about 3 feet deep. It was situated in a basin in the solid rock at the top of what would be a waterfall in the wetter seasons. The only conspicuous vegetation at the water's edge was a clump of sedge about 3 feet in height. The bottom of the pond was covered with sediment.

The hylas were difficult to see against the gray rock, which they matched almost perfectly. When approached, they dove to the bottom of the pond into the muck.

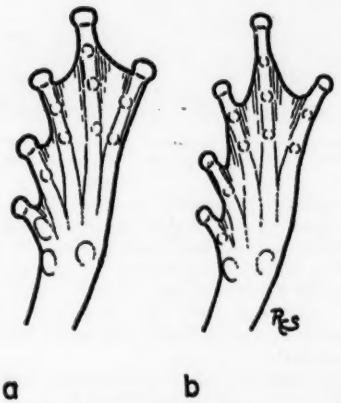


Fig. 1. Hindfoot of *Hyla arenicolor*, a, compared with that of *H. regilla*, b, to show differences in webbing and discs.

Although these individuals were less than half grown, they were readily distinguished from *Hyla regilla* by the structure of the feet. The value of the foot differences in differentiating these species in California seems not to have been adequately brought out. *Hyla arenicolor* has larger toe pads, which are expanded transversely, whereas those of *regilla* are smaller and more rounded; webbing extends farther toward the tips of the toes and the toes are relatively shorter in *arenicolor*. The larger toe pads and more extensive webbing in the canyon tree-toad are probably related to the rocky stream habitat of this species.—GEORGE W. SALT and ROBERT C. STEBBINS, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

NOTES ON A LITTER OF YOUNG TIMBER RATTLESNAKES.—The paucity of information in the literature on the young of *Crotalus horridus horridus* (Linnaeus) is surprising in view of the wide distribution and frequent occurrence of this animal. Conant (1938, The reptiles of Ohio, Amer. Midl. Nat., 20: 119–20) records two litters of these snakes: one of eight young, which measured from 9⅜ to 9⅞ inches, and the other of twelve young varying from 7⅜ to 8½ inches, born September 15 and 13 respectively. Ditmars (1936, The reptiles of North America: 360) states that broods number from seven to twelve and are born from September 6 to 18 inclusive. The following data are derived from a litter of seven snakes in the collection of the Northwestern University Museum, born August 26, 1936, from a female taken July 1, 1936, at Eitzen, Houston County, Minnesota, by Phillip Harter.

TABLE I

Museum	Numbers	Sex	Scale rows	Ventrals	Caudals	Supralabials	Infralabials	Body length	Tail length	Total length
NUM	587	♀	23–23–19	163	20	12–12	14–14	291	27	318
NUM	588	♀	23–23–17	170	19	13–13	15–14	294	25	319
NUM	589	♀*	25–23–19	166	20	13–14	16–16	302	26	328
NUM	590	♂	25–23–19	161	24	12–13	16–14	285	31	316
NUM	591	♀	23–23–17	166	24	12–12	14–14	296	29	326
NUM	593	♂	21–23–19	159	24	12–12	15–14	303	31	334
NUM	594	♀	23–23–19	167	19	12–13	14–14	291	26	317

* Specimen badly mangled in preservation; sex uncertain, but probably a female.

It will be noted from Table I that all of these snakes are appreciably larger, varying from 316 to 334 mm., mean 322.57 mm. (13⅛ in.), than those from litters recorded by Conant. Apparently, these specimens were killed just prior to the time of making their initial shed, as all had the prebutton present, and the body skin and prebutton loosened and ready to shed. As the initial shedding is usually completed a week or two after birth (according to Schmidt and Davis, 1941, Field book of snakes: 292) it seems probable that these snakes are not more than two weeks old, and therefore, somewhat larger than they were at birth.

I wish to thank Dr. Orlando Park of Northwestern University for permission to report on material under his care, and to Dr. Howard K. Gloyd for helpful suggestions.—RICHARD A. EDGREN, JR., *Northwestern University, Evanston, Illinois.*

NOTE ON THE THREE-TOED BOX TURTLE.—On October 11, 1947, during an early morning walk in an open sage brush area above the sea cliffs south of Torrey Pines Park, near La Jolla, California, a specimen of the three-toed box turtle, ***Terrapene carolina triunguis,*** was observed foraging. The length and width of the carapace was 4⁹⁄₁₀ and 3⁹⁄₁₀ inches respectively; the height of the shell was 2⁹⁄₁₀ inches. As this is completely out of range for the species it would appear obvious that this individual had been released by someone. Since the turtle appeared to be in excellent condition it would suggest that the southern California coastal climate is suitable as an ecological range for the species.—A. S. LOCKLEY, *Scripps Institution of Oceanography, La Jolla, California.*

FARANCIA ABACURA REINWARDTII IN OKLAHOMA.—On April 21, 1946, an adult specimen of *Farancia abacura reinwardtii* (UOMZ 24380) was collected in a palmetto (*Sabal palmetto*) grove south of Tom, McCurtain County, Oklahoma. It was caught as it climbed from a narrow roadside ditch containing water. This appears to be the only known specimen of the mud snake from Oklahoma. It is a typical male, 899 mm. in length, with 175 ventrals and 43 subcaudals. The head scutellation and general coloration agree closely with the description and figure of Smith (COPEIA, 1939: 110–117). There are 58 light bands on the body and 12 on the tail.

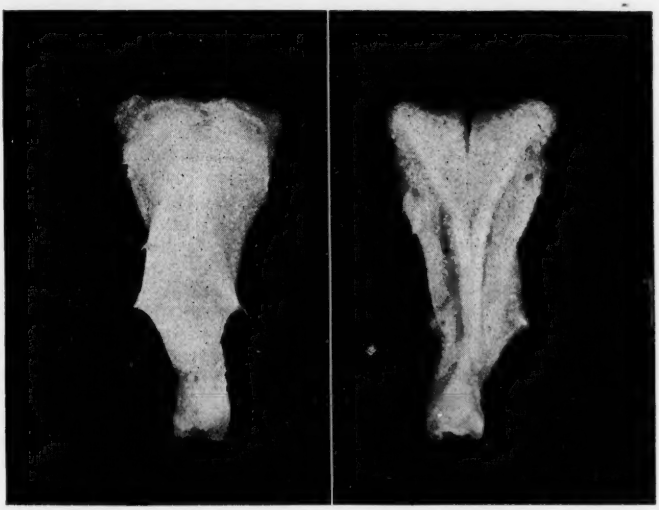


Fig. 1. External (left) and internal (right) surfaces of right hemipenis of *Farancia abacura reinwardtii*.

The hemipenes, which were prepared by the paraffin method of Ortenburger (COPEIA, 117, 1923: 71–72) have a very peculiar and characteristic shape, shown in Cope's figure of the hemipenes of *F. a. abacura* (Trans. Amer. Phil. Soc., 18: 186–219). The accompanying photographs (Fig. 1) show the form of the hemipenes better than could a verbal description.

The occurrence of *F. a. reinwardtii* in Oklahoma is not surprising since there are records of this form from nearby in both Texas and Arkansas.—W. LESLIE BURGER, JR., *Department of Zoological Sciences, University of Oklahoma, Norman, Oklahoma.*

STORERIA OCCIPITOMACULATA IN NORTHWESTERN OHIO.—On July 7, 1946, I collected a specimen of the red-bellied snake, *Storeria occipitomaculata* Storey in Defiance County, Ohio, 1 mile southwest of the city of Defiance. It was taken in open oak-hickory woodland at the top of a dry ravine near mid-day, while apparently sunning itself.

A second specimen was taken on July 16, 1947, a short distance from the spot where the first was secured. It was found crawling across a path in a large clump of hazelnut bushes, late in the morning.

According to all available records these are the only specimens of this species to be reported outside of the Allegheny Plateau in Ohio. The species, however, is known to occur in southern Michigan.

The two specimens are deposited in the reptile collections of the Ohio State Museum. Identification was confirmed by Mr. Roger Conant, of the Philadelphia Zoological Society.—CHARLES A. TRIPLEHORN, *Ohio State University, Columbus, Ohio.*

SALAMANDERS OF THE GENUS *PSEUDOTRITON* FROM GEORGIA AND SOUTH CAROLINA.—In 1928 Bishop applied the name *Pseudotriton ruber vioscai* to a new salamander from Louisiana (Occ. Pap. Bost. Soc. Nat. Hist., 5: 247). Later he defined the range as "the Gulf Coastal Plain of northwestern Florida, Georgia, Alabama, Mississippi, and Louisiana" (1943, Handbook of salamanders: 399). According to his map (*op. cit.*: 390), the form occurs in western Georgia below the Fall Line, extending about as far eastward as Washington or Johnson County.

Extensive series of Coastal Plain specimens in my collection differ from typical *ruber*, and agree with Bishop's race. However, the range of *vioscai* extends farther eastward than has been indicated. Populations of this subspecies are found in Jefferson, Burke, Glascock, and Richmond counties, Georgia, and also in Aiken and Barnwell counties, South Carolina. Corrington's comments on *P. ruber* in the area about Columbia, Richland County, South Carolina, suggest the Coastal Plain race rather than typical *ruber* (1929, COPEIA, 172: 62).

Four adults taken near Kathwood, Aiken County, South Carolina, vary in length from 139 to 141 mm. The dorsum is dark red-brown, the sides and venter pink. The dorsal spots are distinct and mostly separate, but suggest a herringbone pattern. The ventral surface bears many dots which are larger and more numerous on the throat. The under surfaces of limbs and tail are dotted. The snout and sides of the head are thickly sprinkled with white dots on a blackish ground. The dots are also present on the back of the head and neck, and in one specimen even extend posteriorly as far as the level of the fourth costal groove (counted from the axilla). The upper surfaces of both fore- and hind-limbs are black with a sprinkling of white dots. The margin of the lower jaw is black, dotted with white. The portion of the vomerine teeth before the "bend" is short, well separated from its fellow of the opposite side. Specimens from Dunbarton, Barnwell County, South Carolina, agree with those from Kathwood. Both series are evidently referable to *vioscai*.

As might be expected, material from Richmond County, Georgia, shows some approach to typical *ruber*. This is particularly true in specimens from the northwestern or Piedmont side of Augusta. Adults from this locality are dotted with white on the snout and sides of head, like *vioscai*, but often become purplish-brown above with indistinct, fused spots, as in typical *ruber*. The white dots of the head are rarely so numerous as in specimens from farther south. Such examples may be considered intergrades. I previously listed five Richmond County specimens of this type as *r. ruber* (1941, COPEIA, 1941: 177); this was at a time when the status of *vioscai* was unsettled.

Specimens with white-flecked snouts were taken as far above the Fall Line as Taliaferro and northern Columbia counties, Georgia. Typical *ruber* was found at Athens, Clarke County, Georgia.

Southeastern *Pseudotriton* with white-flecked snouts were described as *P. ruber sticticeps* by Cope, who credited the name to Baird (1889, The Batrachia of North America: 178). The type was collected by Dr. W. L. Jones in Georgia. Although Dr. Jones collected mainly in Liberty County, he also amassed considerable material from Augusta and scattered points in north Georgia. All his specimens from Augusta and the upland region (*Cryptobranchus, Gyrinophilus, Plethodon cinereus, Desmognathus quadramaculatus*, etc.) were labeled "upper Georgia" or simply "Georgia"; his Liberty County specimens (*Amphiuma, Siren, Drymarchon, Micrurus*, etc.) were always labeled "Riceboro" or "Liberty County" (cf. Cope, 1900, Ann. Rep. U. S. Nat. Mus., 1898). Riceboro was probably not the type locality of *sticticeps*; indeed, it is unlikely that *P. ruber* occurs there. Furthermore, certain characters of *sticticeps* (a white-flecked snout and a uniform dorsum) suggest intergrades of a type common at Augusta. Accordingly, I feel that the name *sticticeps* Baird should not replace *vioscai* Bishop. However, *sticticeps* might be conveniently revived for the Atlantic Coastal Plain population if it eventually proves different from the Gulf Coastal Plain population of *P. ruber*.

In 1856 Hallowell applied the name *Pseudotriton flavissimus* to a salamander from Liberty County, Georgia (Proc. Acad. Nat. Sci. Phila., 8: 130). This form for many years was listed as *P. montanus flavissimus*. In 1943 Bishop, without comment, again gave it full specific rank as *P. f. flavissimus* (*op. cit.*: 378), trinomials being necessitated

by the description of a Florida derivative, *floridanus* Netting and Goin (1942, Ann. Carnegie Mus., 29: 175). This procedure was justified by the lack of intergradient material from the southeast. However, Netting expressed the opinion that *flavissimus* (and therefore *floridanus*) should be regarded as a subspecies of *montanus* (1945, Ecology, 26: 105). Material in my collection throws considerable light on this problem. For convenience the two forms will be referred to simply as *montanus* and *flavissimus*.

Pseudotriton montanus and *flavissimus* can not be separated on the basis of costal groove count, number of intercostal spaces between the appressed limbs, number and character of vomerine teeth, or percentage of tail length in total length, these characters exhibiting only slight average differences. In fully adult *montanus* the ground color is a bit darker, and the dorsal and ventral spots somewhat more numerous than in *flavissimus*. When series of *flavissimus* are compared with *montanus* of equal size, however, much less difference in coloration is evident. The latter form simply reaches a larger size and carries ontogenetic variation a bit further. In both forms the margin of the lower jaw usually becomes tinged with dusky, and the iris is dark brown or black.

There is a slight difference in head shape, more evident when large *montanus* are selected for comparison. In *flavissimus* the head is elongated, the snout somewhat pointed; in *montanus* the head is more nearly oval, the snout bluntly rounded and convex above. There is also a difference in size. The length of *flavissimus* rarely exceeds 100 mm., the average adult being about 90 mm. in total length, while *montanus* averages about 130 mm. and occasionally reaches 155 mm. or more. Large *montanus* are proportionately stouter than *flavissimus*.

The two forms are obviously closely allied. Of course, their relationship, whether subspecies or full species, does not depend upon degree of difference; but the similarity in this case is suggestive.

Bishop's map (*op. cit.*: 379) reveals that *flavissimus* occurs about as far north as Richmond County, Georgia, *montanus* about as far south as McCormick County, South Carolina. Nothing in this distribution would prohibit a subspecific relationship for the forms in question, provided that intergrades could be found in the narrow strip of intervening territory. The U. S. National Museum has *montanus* from Columbia, Richland County, South Carolina, according to Pickens (1927, Copeia, 165: 108). Fortunately, one need not rely on the literature; a wealth of material is at hand from the critical area.

Eleven specimens were taken between Beech Island and Kathwood, Aiken County, South Carolina, a locality supposedly on the edge of the range of *flavissimus*. The total length of these varies from 94 to 135 mm. The three largest are dark brown dorsally, two being heavily dotted. The venter is dotted in six individuals, nearly immaculate in five. In all the snout is bluntly rounded but not strongly convex, the head elongate, the sides of the head behind the eyes parallel. The series is close to *montanus*, but the approach to *flavissimus* is apparent.

Three specimens were taken about 5 miles north of Shell Bluff, Burke County, Georgia, in what should be *flavissimus* territory. These range from 112 to 117 mm. in total length. The dorsum is a dark brown, the sides and venter orange-yellow. The dorsal spots are thickly clustered and rather indistinct. The under surface is heavily flecked with brown, particularly about the throat and chest. The edge of the lower jaw is broadly margined with black. The head shape is that of *montanus* except that the snout is more pointed. This series seems closer to *montanus* than to *flavissimus*.

A specimen taken near Grahamville, Jasper County, in the lower Coastal Plain of South Carolina, measures 119 mm. in total length. The dorsum and upper surfaces of the limbs are dark brown. The dorsal dots are many, indistinct, extending ventrad to the level of the limbs. Sides and venter are orange-yellow, the latter immaculate. The lateral dots form longitudinal lines, between which are many short, yellow dashes, as in *floridanus*. The head shape is typical of *flavissimus*.

Five specimens, taken in the extreme northern tip of Richmond County, Georgia, range in length from 68 to 100 mm. The dorsum is medium brown, the sides and venter orange-yellow. The back is heavily dotted, the venter lightly so. The lateral spots extend to the level of the limbs. The venter is conspicuously dotted in four of the series. In the largest example, with swollen temporal region, the head shape is that of *montanus*.

In the remainder the head is elongated, the snout blunt. A single specimen, taken a few miles to the northwest in Columbia County, seems to be *montanus*. Specimens from the immediate vicinity of Augusta usually agree with *flavissimus* in all but the shape of the snout. However, some could be called *montanus*. One such is 126.5 mm. in length, with a purplish-brown dorsum and the head shape of *montanus*. The dorsum, however, bears only a few, sharply defined dots and the venter is nearly immaculate.

The account could be prolonged, but from the foregoing it is evident that *flavissimus*, and therefore *floridanus* also, should be listed as subspecies of *Pseudotriton montanus*, intergradation between the typical form and *flavissimus* taking place in the Fall Line region of eastern Georgia and western South Carolina.—Wilfred T. Neill, *Department of Biology, Augusta Junior College, Augusta, Georgia.*

RECORDS OF AMPHIBIANS AND OF THE NORTHERN ALLIGATOR LIZARD IN NORTHWESTERN CALIFORNIA.—While on a canoe and auto trip through the Trinity and Klamath River country of northwestern California from March 22 to April 3, 1947, specimens of the following species were collected in localities hitherto unrecorded:

Gerrhonotus coeruleus principis (Baird and Girard), northern alligator lizard.—March 29: taken under bark of fallen tree by Pecwan Creek, Klamath River, California.

Bufo boreas halophilus Baird and Girard, northern toad. Very numerous at Pecwan and Tectah creeks, Klamath River, California, March 26 to March 31.

Aneides flavipunctatus (Strauch), black salamander.—March 25: one under board at Pull Creek, Hoopa Indian Reservation and Trinity River, California. March 27: two under fallen redwood tree bark at Tectah Creek near Klamath River, California. March 29: one under bark of fallen tree at Pecwan Creek, Klamath River. April 2: one under bark of tree near Boise Creek, branch of Willow Creek, Trinity River, California; four under stones in rocky canyon at Big French Creek, Middle Fork of Trinity River.

Aneides ferreus Cope, clouded salamander.—March 27: three immature individuals taken under the firm bark of a recently fallen tree at Tectah Creek, Klamath River, California. April 2: two adults captured under rocks at Big French Creek, Middle Fork of the Trinity River, California.—Vinson Brown, *271 Clarke Ave., Los Altos, California.*

THE INCIDENCE OF POISONOUS SNAKES ON OKINAWA SHIMA (RYUKYU ISLANDS).—Dr. E. R. Dunn (Copeia, 1947: 156) reports a small sample of snakes from El Volcán, Panama, and notes the extremely high incidence of venomous individuals, 631 (=621?) per thousand. Dunn notes that this may not represent a random sample.

From August to November, 1945, 43 snakes, representing seven species, were taken from the vicinity of the village of Kin on the east coast of Okinawa. This sample probably approximates a random collection, as the greater propensity for individuals to collect poisonous snakes is partially, at least, offset by the nocturnal and more secretive habits of the venomous species.

The proportion of poisonous snakes in this sample is very high. Venomous snakes occur in an incidence of 395 per thousand, which compares closely with the incidence of 311 per thousand reported by Dunn from Puerto Armuelles, Panama.

The species and number of individuals taken are listed below.

Opheodrys semicarinata (Hallowell) ...11
Natrix pryeri (Boulenger) 8
Dinodon semicarinatum (Cope) 6
Typhlops braminus (Daudin) 1
Trimeresurus okinavensis Boulenger 7
Trimeresurus flavoviridis (Hallowell) .. 7
Hemibungarus boettgeri (Fritze) 3

The major portion of this collection has been deposited in the collections of the Chicago Natural History Museum.—James A. Slater, *Department of Entomology, University of Illinois, Urbana, Illinois.*

EMERGENCE OF *COLUBER C. CONSTRICTOR* FROM HIBERNATION.—During April, 1947, I had the opportunity to observe the emergence from hibernation of black snakes, *Coluber c. constrictor* Linnaeus. The observations were made in Western Run Parkway at the edge of a fresh water pond (5 yards in length and a yard in depth), located in a beech-maple forest in the northwest suburbs of Baltimore, Maryland, beginning on April 6, which was sunny, but cool. *Hyla crucifer* was heard peeping, and *Ambystoma maculatum* eggs were in abundance in the pond. My wife, Kathryn G. Cohen, had approached a large beech tree (*Fagus grandiflora*) on the southeast bank of the pond, but stopped when she saw some leaves move at her feet. She called my attention to a large dull-colored blacksnake that was stretched before her, apparently sunning itself. This was at 2:30 P.M.

The bank at that spot was about 3 feet above the level of the pond, and was warmed by the sun, which shone directly on the thick roots of the beech tree. Between two large roots, protruding from a hole, 1½ inches to 2 inches in diameter, were the white-chinned heads of two adult blacksnakes. A later examination of the hole revealed that it dropped vertically for about 12 inches and then opened into an unorganized arrangement of roots and cavities. The hole seemed to have been an old *Microtus* burrow; the edges of its mouth worn smooth by the friction of many snake bodies slithering through it.

By the time we had backed around to the opposite side of the tree trunk, three *Coluber* heads filled the opening of the hole. One snake pushed about 6 inches of its body out and yawned twice, then after twenty minutes of cautious glances and a lot of tongue flashing, it crawled out on the surface of the ground and lay extended for several minutes. Its body was gray with dust, but otherwise it seemed to be in good condition. A second snake had one-third of its body out when it was noosed and slowly drawn out of the hole and behind the tree, where it made wide sweeping strikes with open mouth before it was bagged.

The first snake was allowed to glide away from the pond area—it headed up a timbered hill—before it was collected. It also was powdered with dust and was just as active as the previous specimen.

The third snake withdrew its head into the hole. After a thirty-minute wait five snake heads filled the opening; one of the reptiles crawled out slowly and made its way eastward toward the forested hillside. I followed it as it disappeared and then reappeared, moving slowly through leaves and forest litter. When crawling the snake seemed to investigate every hole and shadow. At 5 P.M. the snake was picked up and placed in the bag with the other specimens.

On returning to the hibernation site I was told that no other snakes had emerged, but that two heads were in the opening. At that time the sun's rays were gone from the roots of the tree.

During the actual emergence each snake behaved in the same manner. It would thrust its head cautiously out of the hole, yawning several times and exposing thin strands of mucus and saliva that stretched from the upper palate to the lower jaw. Whenever a warm breeze blew strongly enough to move the leaves on the ground and with enough force to sway the snake's head it would flash out its tongue and crawl a little farther out, then stop. These same reactions were repeated at each successive breeze until the snake was out on the surface.

Two days later, on April 8, I returned to the site. Air temperature was 12.5° C. *Hyla crucifer* called weakly from the pond. Two *Coluber* heads were protruding from the hole. They drew back when I approached and did not come out during an hour's wait, during which time only their snouts were visible.

On the next visit, April 10, between 5:30 P.M. and 6 P.M., an exceptionally large *Coluber* head peered from the hole. I watched through field glasses from a vantage point on the other side of the pond for about half an hour, but did not see the snake make any move to come out on the surface. Highest air temperature that day was 18.5° C.

On April 12, a visit at noon found no snakes at the opening. Bi-weekly visits all through April, May, June, and July on favorable days for reptile activity did not reveal

any black snakes at the hibernation site, nor on the neighboring hillsides. These repeated visits substantiate the conclusion that the observations were made at a "winter den."

The three male specimens collected measured 918, 1479, and 1525 mm. in body length, the tail being a mere stub in two. The single female measured 1058 mm.

The writer plans to make population studies, including home range and territory of the hibernation "colony" during the following years.—ELIAS COHEN, *Natural History Society of Maryland, Baltimore, Maryland.*

DIAMOND-BACK TERRAPIN IN CONNECTICUT.—The general opinion as one looks through the literature seems to be that the diamond-back terrapin, *Malaclemys terrapin terrapin* (Schoepf), is on the verge of extinction. De Sola (Bull. N. Y. Zool. Soc., 34: 157) states, "the species is still very rare and every effort must be made to foster measures to rehabilitate a terrapin so useful in man's larder." Babcock (1926, COPEIA, 150: 101) states "—commercial turtle-hunters have greatly reduced its numbers," and elsewhere (1938, New England Mus. Guides, 2: 32) advises that "either artificial propagation or restriction of turtle hunting must be resorted to in order to save this terrapin from extinction." Conant (1947, Reptiles and amphibians of the northeastern states: 22) writes "—this turtle has become rare over a large part of its range. It is much hunted for market and most of the states in which it occurs have passed laws protecting it—."

In 1946 and 1947, a partial survey of the coastal area of Connecticut was taken in order to determine something of the frequency and distribution of the Atlantic coast form.

Diamond-back terrapin appear to be common in the marsh at the mouth of the Housatonic River, Milford Point, Connecticut. Mr. D. Anderson, of Milford Point, has informed me that during the past five or six years he has not failed to find three or four each season, and, on September 13, 1946, obtained a female for me, that measured 16 cm. and weighed 690 gms. I observed several specimens there, during 1947, and, in late June, noted egg shells of this species on the marsh side of Milford Point beach.

An observation of this species at Stony Creek, Connecticut, is recorded elsewhere (Finneran, 1948, Herpetologica, 4: 126). One has been observed in the West River, at Guilford, Connecticut. In 1947, following the information generously given by Mr. Paul Farnsworth, of New Haven, Connecticut, I visited the Lieutenant River. Two were observed on one occasion and one turtle on the second.

Mrs. Hubert F. Loveland, of Saybrook, Connecticut, has informed me that they are common along "the creeks and shores of the Connecticut River." Mr. Herbert Warfel, now in charge of the Biological and Oceanographic Investigation, Philippine Fishery Program, informs me that on September 6, 1945, and September 14, 1945, he took several diamond-back turtles, 7 to 8 inches long, from a fyke net at Chalker's Island in the Connecticut River.

The above observations seem to indicate it is becoming a fairly common species along the Connecticut coastline. The fact that Connecticut has no law protecting the diamond-back terrapin is called to the attention of responsible New England zoologists and naturalists.—LEO CHARLES FINNERAN, *2124 Marlborough, Detroit 15, Michigan.*

AN IOWA RECORD OF THE KEELED GREEN SNAKE.[1]—On May 5, 1946, the writer collected a small green snake from a coral-berry (*Symphoricarpus orbiculatus*) bush in the southeast corner of section 4, Salt Creek Township, Davis County, Iowa. Examination showed it to be the keeled green snake (*Opheodrys aestivus* Linnaeus). The specimen has been deposited in the Iowa State College collection.

The range of this snake has been described (Conant and Bridges, What snake is that?, 1939) as extending north in the Mississippi Valley to southwestern Pennsylvania, central Indiana, central Missouri and southeastern Kansas. This record appears to represent a substantial northward extension of the range of this species in the North Central States. It is not known to have been reported previously from Iowa.—W. D. KLIMSTRA, *Iowa Cooperative Wildlife Research Unit, Iowa Agricultural Experiment Station, Ames, Iowa.*

[1] Journal Paper No. J-1448 of the Iowa Agricultural Experiment Station, Ames, Iowa, Project No. 494.

EXTRA-UTERINE EMBRYOS IN SNAKES.—While dissecting a large female *Natrix sipedon fasciata* from Augusta, Georgia, I noticed a chalky, ovoid mass lying in the body cavity of the reptile. When tapped with the butt of a scalpel, the mass flaked off to reveal a well developed embryo, coiled in the characteristic prenatal fashion. Although brittle and heavily calcified, the embryo was remarkably well preserved. I have also seen this phenomenon of extra-uterine embryos in *N. s. pleuralis;* and was told of its occurrence in *Thamnophis radix.*

While it is possible that this is ectopic pregnancy, like that occasionally occurring in mammals, the degree of development of the embryos suggests that the encysted embryo developed normally in the extreme anterior part of the oviduct, and was crowded into the body cavity by the production of an unusually large complement of young; or that contractions of the oviduct during parturition began posterior to one of the embryos, forcing it in the wrong direction. The last theory seems most reasonable, explaining the large size of the embryos, and the fact that the known instances of this anomaly are confined to ovoviviparous species whose oviducts are often crowded with enormous numbers of young. The question arises as to whether such a misplaced embryo would calcify before necrosis began.

It is evident that the physiology of *Natrix* and *Thamnophis* is capable of counteracting such mishaps, for one of the parent reptiles had been in captivity for over a year; and there was no sign of tissue irritation in the peritoneum or viscera.—WILFRED T. NEILL, *Department of Biology, Augusta Junior College, Augusta, Georgia.*

MORE RECORDS OF REPTILES FROM PORTAGE COUNTY, OHIO.—Since my earlier report on Portage County, Ohio (COPEIA, 1944: 252), several additional specimens of the smooth green snake, *Opheodrys vernalis* (Harlan), have come to hand, indicating that this species, while rare in the state as a whole, is rather common in certain sections of the northeastern part of the state. On May 28, 1945, a specimen was killed at Ravenna and sent to me by Miss Hortense Beardsley, who had reported having seen green snakes in her neighborhood over a period of several years.

While moving cinders from a storage pile on the campus of Kent State University on December 5, 1945, workmen uncovered three specimens of the smooth green snake in hibernation. Two were of normal adult size (16.5 in. and 17 in.), while the third was a juvenile only 6.0 inches in total length, a little smaller than the smallest specimen previously recorded for the state. Mr. Kenneth Chiavetta reported finding the same species in this section of the campus several years earlier. On July 22, 1947, a female specimen was collected by workmen from this same locality. It laid an egg on that day that measured 1 1/16 in. in length and 1/4 in. at the greatest diameter. When first deposited the egg was very soft, with a translucent, membranous covering. Gradually the outer covering became opaque and leathery. Two more were laid that night, another during the following night, and a sixth one during the next day. When the snake was preserved on July 26, a seventh egg was found in the uterus.

A male specimen of the common box turtle *Terrapene carolina* (Linnaeus), 4.5 inches in length of carapace, was brought to our laboratory by Mr. Phillip Warmuth, who found it along highway 797 near Twin Lakes on June 7, 1947, immediately after a torrential rain storm. Conant, in "The Reptiles of Ohio" (1938, Amer. Midl. Nat., 20: 1–200), states that this turtle does not occur naturally in northeastern Ohio and that it is unknown to the residents of that part of the state. There was no evidence that the one found had been a captive animal. The locality of our specimen is 40 miles north of the nearest known record for the state.

The map turtle, *Graptemys geographica* (Le Sueur), has been recorded from a single locality (Eagleville, Ashtabula County) in the northeastern corner of the state. On June 24, 1947, a juvenile specimen of this species was collected from Dollar Lake, a bog lake near Twin Lakes, Ohio. The carapace measured 1 7/16 in.

Of the snapping turtle, *Chelydra serpentina* (Linnaeus), Conant states that it undoubtedly occurs in every county. It is abundant in the vicinity of Kent, and is recorded also from Ravenna and Windham.—RALPH W. DEXTER, *Kent State University, Kent, Ohio.*

Ichthyological Notes

TWO ADDITIONS TO THE KNOWN FISH FAUNA OF CALIFORNIA.[1]—In 1939, 1940, and 1941, the U. S. Fish and Wildlife Service, in conjunction with the Scripps Institution of Oceanography, carried out oceanographic work off the coast of California. The biological part of the surveys was concerned with eggs and larvae of the sardine, *Sardinops caerulea* (Girard). Large scale plankton collections made during these years yielded, as a by-product, many interesting oceanic fishes. A report upon this collection is partially completed, but in view of the checklist of California fishes being prepared by Mr. W. I. Follett and Dr. C. L. Hubbs it seems advisable to place on record the following additions to the known California fish fauna.

Argyropelecus sladeni Regan, 1908.—One specimen, 26 mm. standard length; 32° 12′ N., 118° 37′ W.; June 19, 1941; one-meter closing net towed from 210 meters to 190 meters between 1:39 and 1:56 A.M.; depth to bottom, 850 fathoms. The nearest previously known locality is off Panama at 60° 17′ N., 82° 05′ W. or 7° 30′ 36″ N., 78° 39′ W. (Schultz, Leonard P., 1938, Proc. U. S. Nat. Mus., 86 [3047]: 153).

Diogenichthys laternatus (Garman), 1899.—One specimen, 12 mm. standard length; 33° 18′ N., 120° 06′ W.; March 28, 1941; one-meter open net towed from 68 meters to the surface between 9:12 and 9:34 P.M.; depth to bottom, 625 fathoms. One specimen, 17 mm. standard length; 32° 52′ 18″ N., 118° 02′ W.; April 9, 1941; one-meter open net towed from 63 meters to the surface between 2:04 and 2:28 A.M.; depth to bottom, 405-427 fathoms. The nearest previously known locality is off Santa Tomas Point, Lower California, at 31° 33′ N., 117° 01′ W. (Bolin, Rolf, L., 1939, Stan. Ichth. Bull. 1 [4]: 121). Identification of these two specimens was made by Dr. Rolf. L. Bolin.—JOHN C. MARR, *U.S. Fish and Wildlife Service, 450-B Jordan Hall, Stanford University, California.*

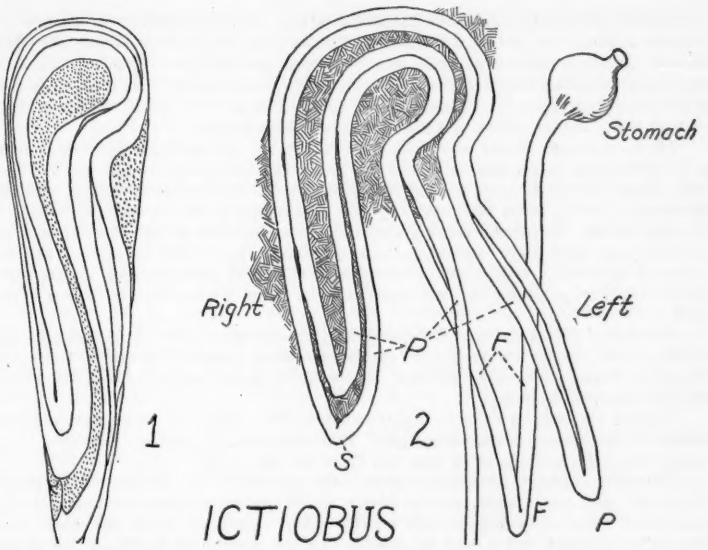
[1]Published by permission of the Director, U.S. Fish and Wildlife Service.

THE INTESTINAL CONVOLUTIONS: NEW GENERIC CHARACTERS FOR THE SEPARATION OF *CARPIODES* AND *ICTIOBUS*.—While working on a fisheries and limnological survey of the Missouri River conducted by the Missouri Conservation Commission, the writer noticed that the intestinal convolutions of *Carpiodes* and *Ictiobus* are conspicuously different.

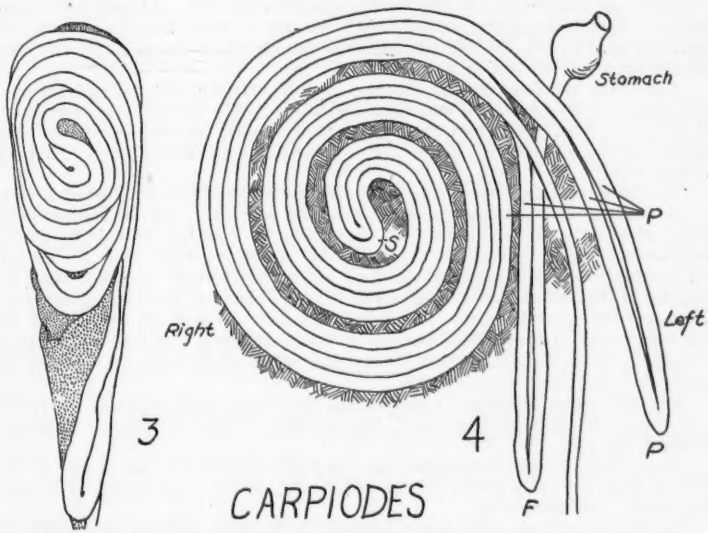
The coiled or circular arrangement of the intestine found in twenty-one unidentified specimens of *Carpiodes* examined contrasts strikingly to the linear or elongate S-shaped arrangement found in fourteen unidentified specimens of *Ictiobus* (cf. Figs. 1 and 3). The basic arrangement, however, is the same in both genera. In the left side of the coelom there are two intestinal loops of about the same length. They lie in the anterior two-thirds of the body cavity, their ends extending caudad (see Figs. 2 and 4). The first loop (F) is formed by a doubling of the intestine a few inches posterior to the stomach—about 3½ inches in 14-inch specimens of either genus. The second includes most of the intestine and therefore may be called the principal loop (P). Most of it is involved in the develop. .t of two secondary loops (S), one within the other, lying in the right side of the coelom.

It is in the length and arrangement of these secondary loops that the generic differences were found. In *Ictiobus* the loops are relatively short and are almost entirely in the right side of the body cavity. In *Carpiodes*, however, they are much longer and are arranged in a distinct coil that extends well into the left side of the coelom.

The University of Michigan gave to the writer one specimen of each of the following species: *Carpiodes carpio, C. velifer, C. forbesi, C. cyprinus, Ictiobus bubalus,* and *I. niger*. These specimens were examined to test the possibility of using the intestinal convolutions in the identification of the species. The results were very promising but not conclusive because of the smallness of the sample. The length of the secondary loops (and, consequently, the position of their termini) was the chief difference noted in the several *Carpiodes* examined.—LESTER M. BERNER, *Box 418, Webster, South Dakota.*



Ventral views showing the intestinal convolutions of *Ictiobus*: Fig. 1, *in situ;* Fig. 2, diagrammatically. Each diagrammatic sketch shows the termini of the first loop (F), principal loop (P), and the two secondary loops (S).



Ventral views showing the intestinal convolutions of *Carpiodes*: Fig. 3, *in situ;* and Fig. 4, diagrammatically.

NOTES ON SOME GULF OF MAINE FISHES.—An examination was made of the complete catches of a 40-foot fishing boat otter trawling for northern shrimp (*Pandalus borealis*) at depths between about 20 and 35 fathoms, one-eighth to 1½ miles off Thrumcap Island, Lincoln County, Maine. Thirty-one species of fish were taken during a total of six hours of dragging in two days fishing during March, 1947. The following captures were of most interest (all measurements refer to total length):

Clupea harengus Linnaeus; herring.—On March 13, 128 specimens ranging from 67 to 166 mm. were caught and, on March 20, 160 of this species between 75 and 223 mm. were taken. Evidently some herring remain inshore in the Lincoln County section, for shrimp boats in the lower Sheepscot Bay area also caught small quantities of herring in the same depths. It is not known if the herring are abundant enough there to warrant a winter purse seine fishery similar to those in Machias Bay, Maine, or parts of the Bay of Fundy shore of New Brunswick, but there is a distinct possibility that winter purse seining would be profitable, in some years at least, along the western part of the Maine coast.

Pomolobus pseudoharengus (Wilson); alewife.—Seventy-eight fish between 72 and 122 mm. were caught on March 13, and 88 specimens between 73 and 118 mm., on March 20. Some of the small alewives, like the herring, stay inshore during the winter, probably near the bottom.

Triglops ommatistius Gilbert; mailed sculpin.—This fish is not uncommon in Maine shrimp catches during March and April. Two specimens, 73 and 85 mm. long, were caught March 13, and one of 74 mm. was taken on March 20.

Merluccius bilinearis (Mitchill); silver hake.—On March 13, 27 young fish between 91 and 147 mm. were caught, and, on March 20, 56 specimens between 85 and 144 mm. were taken. The shrimping grounds off Thrumcap Island are fished for adult silver hake in the summer, and it may be possible that the absence of the larger fish during March was due to their ability to avoid the relatively slow-moving shrimp trawl. Possible avoidance of the net by larger fish may also partially explain the dominance of smaller specimens of alewives and herring in the shrimp catches. The capture of small silver hake within 1½ miles of shore indicates that the wintering grounds of at least some individuals of this species are inshore.

Lumpenus lampetraeformis (Walbaum), snake blenny.—This species is seldom seen except in fisheries employing small-meshed nets such as those used for shrimp. Six specimens, 88, 105, 172, 228 and 285 mm., were caught March 13, and two more, 137 and 196 mm., were brought in March 20.

Leptoclinus maculatus (Fries); shanny.—Five fish, 113, 120, 131, 135 and 138 mm., were caught on March 13, and five more, 101, 102, 121, 125 and 135 mm., were taken on March 20. Shrimp fishermen do not distinguish between this fish, the snake blenny, the radiated shanny (*Ulvaria subbifurcata*) and the rock eel (*Pholis gunnellus*), but call all four "eels."

The fishing operations for herring in the Gulf of Maine incidentally harvest a number of species of fish, principally mackerel (*Scomber scombrus*), dogfish (*Squalus acanthias*), silver hake, pollock (*Pollachius virens*), winter flounders (*Pseudopleuronectes americanus*), sculpins (principally *Myoxocephalus octodecimspinosus* with *M. scorpius* and *Hemitripterus americanus* less common) and smelt (*Osmerus mordax*). With the exception of the mackerel, the herring catches in Maine and New Brunswick seldom contain commercial quantities of the other incidental species. A few of the less common fish have been caught by herring fishermen and brought to the temporary fisheries laboratory at Eastport, Maine, for identification. Among these specimens the following were unusual enough to warrant their being recorded:

Etrumeus sadina (Mitchell); round herring.—A specimen, 173 cm. long, was caught in a herring stop seine at Sand Cove, Marshall Island, Hancock County, Maine, on September 18, 1947.

Sarda sarda (Bloch); common bonito.—On September 24, 1947, one of this species, 310 mm. long, was taken from a herring weir located on the southeast side of Campobello Island, New Brunswick.

Pomatomus saltatrix (Linnaeus); bluefish.—A 144-mm. specimen was caught at Sand Cove, Marshall Island, Hancock County, Maine, in a herring stop seine on September 18, 1947.

Prionotus carolinus Linnaeus; common sea robin.—One of this species, 293 mm. long, was caught in a herring weir at Deer Island, New Brunswick, on September 10, 1947.

Cryptacanthodes maculatus Storer; wrymouth.—Two large specimens of this fish were caught on a herring weir at Big Bay, Charlotte County, New Brunswick, on October 23, 1947. One of them, 757 mm. long and weighing 1170 grams, had the following in its stomach: one 161-mm. smelt, two silver hake, 121 and 137 mm. long, and 10 herring ranging in length from 116 to 165 mm. The other wrymouth, 696 mm. in length and weighing 811 grams, had in its stomach 12 herring between 105 and 155 mm. The crowded condition of the fish entrapped in the weir would enable the wrymouth to capture the smaller fish easily and probably the stomach contents do not indicate the normal diet of this fish.

Further records of fish taken by the herring fishery include the following:

Cetorhinus maximus Gunner; basking shark.—Four specimens of this uncommon shark were taken by herring fishermen in the Passamaquoddy Bay area during 1947. Identification of the fish has been made from photographs and from eye-witness descriptons of the sharks. No length measurements are available, but records of the weights of the individual livers exist. A rough estimate of the total weight of the fish was obtained by multiplication of the liver weight by five.[1] Following are the data for the four sharks:

1. On August 23, a 1795-pound shark was harpooned by a herring fisherman at Welchpool, Campobello Island, New Brunswick.
2. On September 4, a 490-pound specimen was caught in a herring weir at Perry, Maine.
3. On September 12, a 1635-pound shark was removed from a herring weir at St. Andrews, New Brunswick.
4. On September 17, a 1265-pound specimen was caught in a herring weir at Welchpool, Campobello Island, New Brunswick.

These sharks have little commercial value, for the liver oil has a relatively low vitamin content and the flesh is not esteemed. The carcasses of the above were processed at an Eastport, Maine, fish meal plant after the livers were removed.

Alosa sapidissima (Wilson); shad.—On two occasions, July 15 and 22, 1947, hundreds of small shad were seen in loads of herring from Northport, West Penobscot Bay, Maine, weirs. Five shad, preserved for identification, measured 160, 179, 185, 223 and 224 mm. Although many loads of herring from the Gulf of Maine were examined during 1947, no other small shad were seen.

Brevoortia tyrannus Latrobe; menhaden.—In the summer of 1946 menhaden schools were sighted by herring and mackerel purse seiners along the Maine coast where these fish have been uncommon for at least a decade. One seiner, Linwood Brackett of New Harbor, Maine, made two catches of menhaden in 1946. Both times the catches were effected at night in belief that the school consisted of mackerel. As menhaden have little commercial value in Maine, the fish were released from the nets. One of these schools was caught in Muscongus Bay and the other in Casco Bay. Brackett reports that increasing quantities were seen during 1947. One purse seiner caught 14,000 pounds off Bailey Island in the summer of 1947 and sold them for lobster bait. On November 18, 1947, a 106-mm. menhaden was found in a load of herring from a Howard Bay, Washington County, weir.

Scomber scombrus Linnaeus; mackerel.—This species usually disappears from the coastal waters of the Gulf of Maine during the late fall. During 1947, mackerel were caught by herring gill nets throughout December near Grand Manan Island, New Brunswick. The last catch of the year was one of 2,413 pounds taken on December 30. These fish were of fairly uniform size, ranging from 280 to 350 mm. Another late record is that of three large mackerel caught in groundfish gill nets off Casco Bay and landed at Portland, Maine, on January 12, 1948.

Menticirrhus saxatilis (Bloch and Schneider); kingfish.—A 47-cm. mutilated specimen of the kingfish was removed from the mouth of a hair seal (*Phoca vitulina*) which had been killed in a West Point fish trap on August 2, 1941.

---

[1] Maine fish liver processors state that the liver comprises 20 per cent of the shark's total weight. I have no personal observations on this matter.

At Boothbay Harbor, Maine, a fish cultural station is maintained by the U. S. Fish and Wildlife Service and occasionally fish are brought to the hatchery for identification. Among these fish were the following, all of which are not commonly found in Maine coastal waters:

Somniosus microcephalus (Bloch and Schneider); Greenland shark.—A specimen about 365 cm. was caught by two line trawl fishermen 25 miles SSW of Boothbay Harbor on March 26, 1945. Identification of the fish was made by T. H. Dorr and E. C. Barter, both of the fisheries station.

Conger oceanica (Mitchell); conger eel.—An 11-cm. larva of the American conger was dipped from a Boothbay Harbor lobster pound during the summer of 1937.

Pomatomus saltatrix (Linnaeus); bluefish.—On July 26, 1939, a sportsfisherman caught a 25-cm. bluefish at the mouth of the St. Georges River, Thomaston.

Centropristes striatus (Linnaeus); sea bass.—A 30-cm. fish was caught by a sportsfisherman at Cozy Harbor, Southport. This sea bass was kept in an aquariam at the hatchery for several months.

Mola mola Linnaeus; sunfish.—A sunfish about 120 cm. long was harpooned off Cape Newagen on August 9, 1941. Although badly wounded, the fish lived for several days in a live car at the hatchery.—Leslie W. Scattergood, *U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.*

THE MOSQUITOFISH, *GAMBUSIA*, ESTABLISHED IN THE GREAT LAKES REGION.—The question of whether or not the western mosquitofish, *Gambusia affinis affinis* (Baird and Girard), has become established in the drainage area of the Great Lakes has arisen in a recent publication of Hubbs and Lagler (Fishes of the Great Lakes Region, 1947). The statement on page 78 of that volume that *G. a. affinis* was ". . . Stocked (and established ?) in various localities about Chicago and in lower Michigan . . ." infers that the species is not yet established. It seems reasonable that the animal in question, having survived more than two decades under natural conditions in an area to which it is not indigenous, is pretty well established.

In an earlier paper (Copeia, 1944 (2): 82–85), the present writer has shown that the western mosquitofish was introduced into Whitman's Pond (Lake Michigan drainage) near Winnetka, Illinois, from Carbondale, Illinois, in 1923 and again in 1925. It is believed that a hardy strain, capable of withstanding the more rigorous climate of the Chicago region, developed during the subsequent ten years. Since 1933 mosquitofish originating from the stock in Whitman's Pond have been widely disseminated throughout Chicago and its environs as a mosquito abatement measure. Much of that planting has been done in waters in the drainage area of the Chicago River, which empties into Lake Michigan. Other plantings in the Des Plaines River drainage have had access to Lake Michigan through the canals present in that area. It is true that many of the plantings made by the mosquito abaters come to naught because the ponds dry up, freeze solid, or are too shallow to support fish life during the winter months. Whenever restocking of such waters is required, the "native" stock that emanated from Whitman's Pond is used. That stock has successfully maintained itself, without reintroductions, in the Chicago region for at least 22 and perhaps for 24 years. During that period it is likely that the species passed through at least one and maybe two generations each year.

An introduction of the same Carbondale stock that was taken to Whitman's Pond in 1923 and 1925 failed to become established when introduced into other ponds in the Chicago area in 1928.

It was from the Chicago stock that introductions into Michigan were made in June, 1941. Some of those plantings have survived in their original localities without restocking for the past six years. Also, individuals of the Chicago stock have been introduced into New York, New Jersey, Ohio, Wisconsin, Ontario, and probably elsewhere, since 1941. Although it may be questionable that the plantings of mosquitofish of the Chicago stock in Michigan and elsewhere are well established, there is no doubt that the western mosquitofish is established in the Great Lakes Basin in Cook County, Illinois.—Louis A. Krumholz, *Dept. of Zoology, Indiana University, Bloomington, Indiana.*

NEW RECORDS FOR THE FISH, *MYRICHTHYS TIGRINUS*, A SNAKE EEL OF THE EASTERN TROPICAL PACIFIC, WITH A RELOCATION OF THE TYPE LOCALITY.[1]—This species is here added to the California fauna on the basis of a single specimen 505 mm. in total length, from San Francisco Bay. This extends the range northward from the southern tip of Lower California. The species was originally described by Girard from "Adair Bay, Oregon," a place that has never since been found. The "Adair Bay" record would appear to be erroneous, as all accounts of this species have delimited its range to an area extending from the inner coast of Lower California to the northern part of Ecuador. Girard, in giving the type-locality as Oregon, evidently confused the locality data. The only Adair Bay known which might conceivably have been the real locality of collection is the Adair Bay of Sonora, Mexico, at the head of the Gulf of California. It seems much more reasonable to let this stand as the type-locality than an unknown place in Oregon where it is almost certain the species never occurs.

Previously this species has been recorded in the literature from the following localities: San Jose del Cabo, Lower California; La Paz Bay, Lower California; Hidden Harbor (Puerto Escondido, Lower California); Pichilinque Bay, Lower California; Adair Bay, "Oregon" [Sonora, Mexico]; Mazatlan, Sinaloa, Mexico; Acapulco, Guerrero, Mexico; Chame Point, Panama Bay; Panama, Panama Bay; and Salinas, near Santa Elena, on Punta de Santa Elena, Ecuador. Specimens in the collections of the California Academy of Sciences and Stanford University establish the species from additional localities: Bocochibampo Bay (Inlet), 3 miles northwest of Guaymas, Mexico, January 2-4, 1946, 2 specimens (Calif. Acad. Sci. No. 18490)[2]; same locality, March 30, 1946, 1 specimen (Calif. Acad. Sci. No. 20240)[2]; Academy Bay, Indefatigable Island, Galapagos Archipelago, May 5, 1932, 2 specimens (Calif. Acad. Sci. No. 3962); San Felipe, Lower California, May 11, 1937, 1 specimen (Stanford Univ. No. 33922)[3]; Isla Partida, Lower California, 24° 31′ 45″ N., 110° 23′ W., May 17, 1939, 1 specimen (Stanford Univ. No. 39792)[3]; Velero Station 798-38, Cartago Bay, Albemarle Island, Galapagos Archipelago, January 21, 1938, 1 specimen (Stanford Univ. No. 37372).[4] From the literature this form seems to be most common in the region of Mazatlan, Mexico. Apparently it has not yet been recorded from the outer coast of Lower California.

The specimen from San Francisco Bay (Calif. Acad. Sci. No. 20236) received from the University of California at Berkeley, bore no other data than "San Francisco Bay, Calif. Presented by a fisherman, June 1931." It does not differ appreciably from others from Mexico and from the Galapagos Archipelago except in the shorter head. The following data were obtained from it: depth 19.1 mm.; head (38 mm.) 13.3 in total length; snout 7 mm.; orbit 3.8 mm. in diameter; least interorbital width 5.9 mm.; lower jaw included by the length of one eye-diameter; length of gape 11.8 mm.; lens of eye posterior to middle of length of gape; anterior nostril in a well developed tube with a slightly flaring fringed rim; maxillaries, mandible, palate and floor of mouth covered with small slender papillae, which appear like minute canine teeth; the short, bluntly conical teeth largest on intermaxillary plate, which anteriorly bears one small, median tooth followed by three rows of large teeth; posteriorly there are two rows of teeth merging with the vomerine band; the latter is compressed posteriorly with two rows of teeth extending back almost to angle of mouth; maxillary teeth in two rows, originating at base of intermaxillary plate, curving moderately outward posteriorly, and terminating below hind border of eye; upper and lower jaws each bordered by a row of 8 well developed pores; a line of 6 pores originating on snout extends back above the eye, encircling the upper posterior border of eye; a median pore present in interorbital; lateral line with approximately 124 minute pores extending to the horny tail.

Dorsal fin origin slightly behind midpoint between angle of mouth and gill opening;

[1] I wish to thank for assistance Rolf L. Bolin of the Hopkins Marine Station, W. I. Follet and Mary Louise Perry of the California Academy of Sciences, and George S. Myers of Stanford University.

[2] Abundant at low tide under rocks in small pools among large boulders on a sandy beach. They quickly disappeared into the sand when disturbed. A young specimen was brought back alive to the Steinhart Aquarium by the collector, Donald A. Simpson. Seldom would this eel come completely out of its burrow, but habitually remained with only its head exposed above the sand. At the slightest disturbance it would back down its burrow with extreme rapidity.

[3] The collector, S. A. Glassell, found this species in a sand beach at low tide. He observed that it burrowed into the sand tail first. Further reference to this habit is given by Myers and Storey, 1939, Stanford Ichth. Bull. 3(4): 157.

[4] Collected at the surface with the aid of a light.

dorsal and anal fins extend almost to end of tail; distance from snout to anal fin origin 211 mm.; pectoral fin flap-like, broad and short, 4 mm. in length, 1.5 mm. shorter than width at base; the latter greater than length of gill opening.

Coloration of head as in other specimens examined; body with three longitudinal rows of dark spots, the dorsal and ventral series continuing onto the dorsal and anal fins; a median row of smaller, lighter spots between anus and head; another series of spots begins on the dorsal fin near the edge; dorsal with narrow white border.

The following are additions to the extensive synonymy of this species given by Storey (1939):

Myrichthys tigrinus.—Günther, 1870, Cat. Fishes Brit. Mus., 8: 19 (name only; comparison). Jordan, 1895, Proc. Calif. Acad. Sci., Ser. 2, 5: 402 (name only; Mazatlan Harbor, Acapulco, Panama). Breder, 1928, Bull. Bingham Oceanogr. Coll., 2(2): 3 (name only; Conception Bay; San Jose del Cabo; Hidden Harbor). Storey, 1939, Stanford Ichth. Bull., 1(3): 78 (description, synonymy). Fowler, 1943, Fish Culturist, 23(2): 12, fig. (description, synonymy; Salinas, Ecuador). Fowler, 1944, Mon. Acad. Nat. Sci. Philad., 6: 486 (name only; Salinas, Ecuador; Mazatlan, Mexico).

Myrichthys xysturus.—Jordan and Evermann, 1898, Bull. U. S. Nat. Mus., 47(1): 2808 (description[5]). Jordan, Evermann and Clark, 1930, Rep. U. S. Comm. Fish., 1928 (2): 85 (name only; Mazatlan, Mexico). Fowler, 1944, Mon. Acad. Nat. Sci. Philad., 6: 486 (name only; Mazatlan, Mexico).

Ophichthys xysturus.—Jordan and Gilbert, 1883, Proc. U. S. Nat. Mus., 4: 346 (original description; Mazatlan, Mexico).—Robert Rees Harry, *Natural History Museum, Stanford University, California.*

[5] The synonymies of *M. tigrinus* and *M. xysturus* are confused. The latter is listed separately and also, immediately above, as a synonym of *M. tigrinus*. In the reference to *M. xysturus* under *M. tigrinus*, the wrong generic name is cited (*Ophisurus* instead of the correct *Ophichthys*), while in the synonymy of *M. xysturus*, the wrong volume number (9 instead of 4) is given.

COLOR NOTES ON PACIFIC MANTA, INCLUDING A NEW FORM.—During the month of June, 1946, I made collections at the islands of Afuera and Contreras del Norte off Bahia Honda, Panama. At both islands I observed and harpooned what I believed to be three different species of large rays.

Fig. 1. Ventral view of wing of the black manta to show eye spot.

Manta hamiltoni (Newman), ray No. 1, was easily recognized by the white shoulder bars. Ray No. 2 was different in shape, smaller in size, and was black above and white below. It appeared to be *Mobula lucasana* Beebe and Tee Van. We never landed ray

No. 2. I did get my hand on the dorsal surface of one specimen, however, and was surprised to find it rather smooth.

Ray No. 3 (black variety) was eventually landed. It differed from typical *hamiltoni* in lacking the white shoulder bars. It proved to be all black, except for a white eye on the ventral surface of the left wing and for a large white spot on its chest (see photographs).

Fig. 2. Ventral view of head of the black manta.

Comparative measurements with *M. hamiltoni* (from Zoologica, Oct., 1941, 26: 275) were as follows:

	M. hamiltoni	*Black variety*	*Ratio*
Total spread	4572 mm.	4671 mm.	1.02
Lower jaw to anus	1800 mm.	2020 mm.	1.11
Width of mouth	870 mm.	787 mm.	0.91
Length outer border ventral fin	520 mm.	....	
Length inner border ventral fin	....	356 mm.	
Width eye to eye	1400 mm.	1193 mm.	0.85

At the island of Contreras del Norte we habitually hunted *Manta hamiltoni* for cinematographic purposes. This ray was about ten times as common as the black form. After four or five days all the standard *M. hamiltoni* suddenly disappeared from the waters around the island. Two of the black variety, however, remained in the vicinity. The one measured and shown in the photographs, a female, was secured on June 14, 1946.—Otis Barton, *1 West 54th Street, New York City.*

REVIEWS AND COMMENTS

VIE ET MOEURS DES AMPHIBIENS GRENOUILLES, CRAPAUDS, TRITONS, SAMALANDRES, CECILIES. By Fernand Angel. Payot, Paris; 1–317, figs. 1–137. 360 frs. 1947.—The late G. K. Noble was so greatly impressed by the excellence of the little work *Les Batraciens* by G. A. Boulenger (1910) that I am certain that it may be regarded as ancestral to his own *Biology of the Amphibia* (1931). The new work by Angel is even more directly derived in turn from Dr. Noble's work, for he has wisely used many of its illustrations. The American volume having stupidly been permitted to go out of print, it is necessary to turn again to the French for the most modern available reference. As a matter of fact, the student who intends to be a herpetologist will require a modicum of French in any case, and could scarcely do better than to use this excellent new work as an introduction to French as well as to the study of the life and habits of the amphibians of the world.

The book has the merit of presenting a compressed review of the caecilians, salamanders, and frogs and toads that exhibits little of the lag behind the current state of knowledge all too characteristic of textbooks. It is focussed, as the title implies, on the modes of life and habits of its subjects, and thus on one of the most interesting aspects of herpetology, which, at the same time, is the one to which the amateur student can make the most valid contribution. In fact, the reviewer heartily subscribes to the publisher's advertisement which ends "Thus presented, in a form both interesting and instructive, we hope that the reader will find in it stimulation to interesting observations of his own and to judicious reflection." One might imagine the Duméril and Bibron looking down with approval upon their latter day successor at the Paris Museum.

It is somewhat dismaying to find that my one contribution to the excellent bibliography is the little essay "How to make money from frog-farming"; but it is gratifying and somehow amusing to find its sarcasm so neatly and cleverly converted into French (pp. 255-257) with the flattering comment that in it "l'humour s'allie aux conseils avisés." The would-be frog farmer should indeed turn his attention from *Rana goliath* to *Rana oxyrhynchus gribinguiensis*, which has disproportionately long and powerful hind legs (Fig. 18).

Angel's chapter headings summarize the emphasis and content of the book. Classification and anatomy are briefly dealt with in the Introduction. Then follow Ecology—Ethology; Locomotion and Movements; Food and Voice, Organs of Sense; Respiration; Skin and Coloration; Glands and Poisons; Intelligence and Instinct; Vitality and Regeneration; Reproduction; The Eggs; Larvae and Tadpoles; Uses of Amphibians in Human Economy; Habits of Frogs and Toads of France; Habits of Salamanders and Newts of France; and Legends, Errors and Prejudices. There is a 12-page bibliography, but the book is unhappily without an index.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago, Illinois.*

THE WORLD'S GREAT LAKES. By Ferdinand C. Lane. Doubleday and Company, Inc., 1948: 254 pp. $3.50—In this popular and highly readable account, Lane offers a great diversity of information on the world's larger lakes—touching on such matters as: origin, present status, and fate; area, form, depth, mineral content, and fluctuations in level; climate, topography, and peoples of surrounding terrain; role in history; importance in transportation and commerce, . . . Faunal references are few and sketchy. The treatment is by continents, with special chapters at the beginning and end of the book on such topics as the formation and destruction of lakes, the effects of lakes on civilization, and man's activities in relation to the utilization and preservation of resources of water.—RALPH HILE, *University Museums Annex, Ann Arbor, Michigan.*

LA VIE DES CAMELEONS ET AUTRES LEZARDS. By Fernand Angel. Gallimard, Paris: 1–220, illus. 40 fr. 1943.—The question with which M. Angel opens his little book on lizards "What is a Chameleon?" is extraordinarily appropriate for American readers, for this term is so much misapplied to the little anole of the southeastern United States, and the true chameleons are so little known to the American public, that the confusion is often compounded by referring to the anole as the "American chameleon." The confusion arises from the fact that color change was long most thought of in connection with the true chameleon; the anole changes its color from green to brown; hence the simple but false conclusion that an anole is a chameleon. Both anole and chameleon are outdone in rapidity of color change by the common arboreal lizard of the southeastern Asia, the "bloodsucker" (*Calotes versicolor*).

The space devoted to a general account of the variety, appearance, color-change, and habits of the chameleons is actually less than 80 pages, and the rest of the book gives a brief account of the appearance and habits of other lizards. In contrast with the illustration in *La Vie et Moeurs des Amphibians,* the illustrations in the present work are crude and inadequate. These need not deter from its purchase the young herpetologist who wishes to improve his French, for as book prices go *La Vie des Cameleons* at 40 francs is one of the least expensive of herpetological works.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago, Illinois.*

AUS DEM TIERLEBEN DER TROPEN REISEBILDER AUS ASIEN, AFRIKA UND AMERICA. By Robert Mertens, Kramer, Frankfurt am Main, 1940: 1-248, 220 figs.[1]—It is extremely gratifying, in catching up with the delays of book distribution during the war years, to discover Robert Mertens' account of his three principal tropical collecting trips in a book excellent in both format and content, being "Senckenberg-Buch 9." An interest in books of travel by his fellow naturalists is an inevitable one for the professional equally with the amateur naturalist. I have given some expression to my own interest in this field in reviews in COPEIA and in critical essays in *The Chicago Naturalist* (1943, 6: 29 ff.).

Dr. Mertens' expeditions had taken him to the East Indian Sunda Islands, to West Africa, and to the island of Hispaniola in the West Indies. Far from this geographic dispersion of interest being a defect in his book, it develops that the explicit and implicit comparisons of these three great tropical regions are especially noteworthy.

Since their author is a professional herpetologist, with a long series of technical reports on amphibians and reptiles well known to his colleagues, it is not surprising that his travels were focussed especially on the collecting of these creatures and on observation of their habits. While the book is thus richly herpetological, the accounts of the sea voyages, of tropical beaches, of noteworthy birds and mammals, and of notable landscapes with characteristic vegetation form a background on which the lizards and snakes and tree-frogs are seen in their proper perspective. A selection of the chapter headings may serve to convey the general scope of the book to the reader of this review: "From the Mediterranean to the Java Sea," "The Giant Lizard of Komodo," and "The Reptile Temple at Penang;" "Along the West Coast of Africa," "About the Chameleons of Mt. Cameroon," and "Zoological Notes from a Banana Ship;" and "In the Sargasso Sea," "Excursions in the Vicinity of the Capital City of the Dominican Republic," and "On the Search for the Giant Tree Frog."

The last of Dr. Mertens' journeys took him to Hispaniola, the scene of my own first love among tropical islands. Thus it is pleasant and nostalgic to find *Anolis olssoni* Schmidt (p. 188, fig. 166) and even its type-locality, the Moro of Monte Cristi (fig. 198), in these pages. Mertens describes especially the peculiar habit of rigid posturing of *Anolis olssoni* in its bunch grass habitat niche, where its long tail and lineate pattern enable it to disappear before one's eyes, by "freezing," when disturbed. Thus my good friend Axel Olsson (now the eminent geologist), my most active German herpetological colleague (now Director of the Senckenberg Museum), and I are held in friendly recollection through a little grass-anole.—KARL P. SCHMIDT, *Chicago Natural History Museum, Chicago, Illinois.*

[1] Price not available.

THE BOOK OF TROUT LORE. By John Crowe. A. S. Barnes and Company, New York, 1947: 233 pages, 50 illustrations. $3.75.—This is not "just another book on trout fishing" but a fresh, original and modern approach to a subject old even before Izaak Walton. Lack of pretense and frank admission that there is still much to be learned about trout and their taking pervade the text. But the author denies that trout are endowed with unusual sagacity and perception. Good tackle, patience and persistence in studying the habits of the quarry and in fishing are stressed as requisites of the successful angler.

Beginning with a brief discussion of the natural history of trout, stressing the senses and the habits most closely related to fishing, the author describes clearly and concisely the equipment needed for various methods of angling.

The value of the scientific approach in trout fishing, including the keeping of creel census records, is stressed. The author's experiments in presenting lures are described to inspire others to study their methods and improve their technique. Various theories of anglers are discussed—the value of matching natural insects, the importance of fly and leader appearance, when to fish, and the influence of weather and water conditions.

The choice of angling companions, the importance of an attitude of confidence—"trout can be caught"—and the urgency of going fishing more often are short, pithy chapters closing the book.

One feels that John Crowe will write better books on angling but that he will not need to be ashamed of his first effort.—ALBERT S. HAZZARD, *Institute for Fisheries Research, Michigan Department of Conservation, Ann Arbor, Michigan.*

FISHES OF THE GREAT LAKES REGION. By Carl L. Hubbs and Karl F. Lagler. Cranbrook Institute of Science, Bloomfield Hills, Mich., Bulletin No. 26: vii + 186 pp., 251 figs., 26 colored pls. 1947. Waterproof binding, $3—Hubbs and Lagler's well-known *Guide* to Great Lakes fishes (reviewed in COPEIA, 1941, 4: 275), itself an expansion of a previous key, has now been enlarged into a full-fledged book. A number of changes are evident, all of which go to make the work of greater use, both to amateurs and to professionals. Most striking is the addition of many illustrations; almost every species is figured, and for many of the common ones colored plates have been provided. The latter are mostly those which graced Forbes and Richardson's *Fishes of Illinois*—the most accurate and lifelike series of colored illustrations of the fishes of a single area ever published.

In the text, we note the addition of a section on glacial and postglacial drainage of the area covered, and a summary of canals which may have affected present fish distribution, both very useful to the ichthyologist. There is also a fine new section on methods of collecting and preserving, with especial attention to the method of taking ecological notes, which should be in the hands of every student of fishes. The accounts of species have been revised throughout in accord with the latest information, and the number of species treated has risen from 167 in the *Guide* to 172 in the new book.

The same praise that the reviewer bestowed upon Hubbs and Lagler's *Guide to the Fishes of the Great Lakes* in 1941 is due the present work, and in greater measure. For a manual designed principally for the correct identification of the fishes of a particular region of wide extent, this book is probably the most accurate and useful ever published. As a piece of bookmaking, however, the new book is inferior to the *Guide*, in spite of its serviceable cover and stronger binding. The paper is too thin and transparent, the printing showing through on the reverse, and the typography is far less readable and pleasing. The fine, clear drainage map of the *Guide* has been reduced in size, poorly printed on spongy paper, and relegated to the cover linings, whither most present-day U. S. publishers take fiendish delight in banishing important maps. It never seems to occur to these gentlemen that books of permanent value and interest are subject to long use and thus to rebinding, and that binders almost invariably destroy the old linings. Nor do they appear to be aware that both librarians and book owners like to paste book plates, to say nothing of library-card envelopes, on the linings of books. At least the publishers of this work have spared us that other modern anathema—"bleeding" illustrations off the edge of the page, where the rebinder, when trimming, will almost certainly deface important figures.—GEORGE S. MYERS, *Natural History Museum, Stanford, Calif.*

THE WAYS OF FISHES. By Leonard P. Schultz (with Edith M. Stern). D. van Nostrand Company, New York, 1948: 264 pages, 80 figures. $4.00—In this book one of America's foremost ichthyologists has abstracted and compiled some of the outstanding portions of the literature on habits of fishes and has generously supplemented this material by accounts of fish habits drawn from his extensive experience with fresh- and salt-water fishes. Chapters are devoted to migration, locomotion, hibernation and estivation, fishes dangerous to man, feeding habits, associations, fighting, electricity, sound and sight, and other subjects.

The material presented represents a very limited selection under each major topic, being restricted largely to those accounts of ways and habits which are highly unusual, spectacular, or bizarre. The title of the book, which would imply a rather general treatment, is thus quite misleading. To illustrate the limitations of the volume, the chapter on migration is principally an account (but a fine one) of the epic of the Atlantic eels; the chapter on locomotion is mostly concerned with fishes that jump, fly, walk, skip, and burrow; and under feeding habits most space is allotted to the archers, anglers, and bloodsucking lampreys.

Especially noteworthy is an appendix on Classification of Fishes which purports to be a complete list in phylogenetic sequence of orders and families of both fossil and recent fishes. There is a general index.—GERALD P. COOPER, *University Museums Annex, Ann Arbor, Michigan.*

EDITORIAL NOTES AND NEWS

Lerner Marine Laboratory

THE AMERICAN MUSEUM OF NATURAL HISTORY has a new, ichthyological outpost in the LERNER MARINE LABORATORY, established by Mr. MICHAEL LERNER in 1947 on the island of BIMINI, 60 miles due east of Miami, Florida. The island sets on the edge of the Grand Bahama Bank and at the edge of the Gulf Stream.

In addition to regular Museum staff, the laboratory can accommodate a limited number of other investigators selected by invitation. Transportation by plane or boat can be chartered at Miami. Application should be made to the American Museum of Natural History, Department of Fishes and Aquatic Biology, New York 24, New York. A brochure on the laboratory is available.

Norman's History of Fishes

REPUBLICATION in America of a small edition of J. R. NORMAN'S *A History of Fishes* is announced by A. A. Wyn, Inc., New York. Date of release was April 29; the price, $6.50. Most students of fishes know this book well. It is nontechnical, detailed, and comprehensive. Chapters are devoted to such subjects as form, locomotion, distribution, structure, breeding, food, and other phases of morphology, ecology, and natural history, to fisheries, fishery research, and even fish mythology. There is an extensive index.

This outstanding treatise on general ichthyology has been in very considerable demand and at times has been unobtainable. Ernest Benn, Limited, London, England, published a third edition of the book in 1947, copies of which are available from British booksellers at approximately $4.75 (including postage) or from some American book stores at $4.50. We trust that the higher price on the American edition will be accompanied by an improvement in quality of paper and binding over the latest Benn edition.

News Notes

A COMMUNICATION from DR. CARL L. HUBBS (Scripps Institute of Oceanography, La Jolla, California) indicates that DR. ERNA MOHR of the Zoological Museum of Hamburg (Jungiusstr., 6, Hamburg 36, British Zone, Germany) is very anxious to complete her set of COPEIA. Through the aid of American colleagues, she has received all missing numbers excepting 1940, Nos. 1 and 3, and 1945, No. 1. Any member who would be in a position to fill this need would confer a favor on Dr. Mohr. It is suggested that such person get in touch with Dr. Hubbs, as this would avoid possible duplication.

DR. JAMES OLIVER has joined the staff of the University of Florida Department of Biology, Gainesville.

The SOCIETY OF SIGMA XI recently made a research grant of $150.00 to ERNEST A. LACHNER, Assoc. Professor of Fisheries Biology at Pennsylvania State College. The grant was used by Lachner and Mr. Paul S. Handwerk, a graduate student at Penn State, to defray partially the expense of a fish collecting trip in southeastern states to obtain material for systematical studies. Allocation of this grant was made by the Committee on Award of Grants-in-Aid of that Society.

PROF. ALFRED WILLER, Ph.D., M.D., has recently resigned as "ordentlicher Professor" of the University of Berlin and Director of the Reichsanstalt für Fischerei, to accept a chair, "Professor der Fischereiwissenschaft," at the University of Hamburg. This information comes to us through DR. A. D. HASLER. Prof. Willer is anxious to exchange publications so as to build up a library for the newly created Institut für Fischereiwissenchaft at the University of Hamburg. His address is Hamburg-Blankenese, Elbchaussee 95, Germany. Fishery literature is at a premium in Central Europe owning to heavy destruction during the war. Prof. Willer has sent the following list of fishery research institutes located in the zones of Germany occupied by the United States, Britain, and France; their status generally is indecisive, therefore organizations pursuing applied and fundamental research are listed indiscriminately owing to lack of information at present. (Only three of the institutes in the Russian zone of occupation are again in operation.)

ORGANIZATIONS FOR FISHERY RESEARCH AND TEACHING IN GERMANY

Chair of Fishery biology at:
- Universität Berlin
- Universität Hamburg
- Universität München; a professor in zoology lectures in the School of Veterinary Science

Lectureship in fishery biology at:
- Technische Hochschule in Hannover

Instructorship in fishery biology at:
- Universität Kiel
- Universität Greifswald

Hochschulinstitute für Fischerei:
- Institut für Fischereiwissenschaft an der Universität Hamburg
- Fischereiabteilung des Instituts für Meereskunde in Kiel-Kitzeberg
- Seminar für Fischereiwesen der Landwirtschaftlichen Fakultät der Universität Berlin (to be renamed: Fischerei-Institut der Univ. Berlin)
- Bayerische biologische Anstalt für Fischerei zu München
- Institut für Seenforschung u. Seenbewirtschaftung Langenargen am Bodensee

Institutes independent of Universities:
- Reichsanstalt für Fischerei in Berlin-Friedrichshagen. This organization was composed of 17 laboratories, but, since allied zoning these have become somewhat independent and are now called:
  - Institut für Fischverarbeitung in Hamburg
  - Institute für Hochseefischerei in Hamburg
  - Institute für Küsten-und Binnenfischerei in Hamburg. (It is not yet certain if the above three will exist separately)
  - Institut für Meeresforschung of the State of Bremen, formerly Institut für Fischverwertung der Reichsanstalt für Fischerei in Wesermünde
  - Institut für Forellenzucht, Albaum Sauerland
- Biologische Anstalt Ellenbogen auf Sylt, formerly Staatliche Biologische Anstalt auf Helgoland

COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

Officers

Honorary Presidents—JOHN TREADWELL NICHOLS (Ichthyology), American Museum of Natural History, New York 24, New York; HELEN T. GAIGE (Herpetology), 1211 Ferdon Road, Ann Arbor, Michigan.

President—M. GRAHAM NETTING, Carnegie Museum, Pittsburgh 13, Pennsylvania.

Vice-Presidents—(Conservation) CHARLES F. WALKER, Museum of Zoology, Ann Arbor, Michigan; (Revolving Research Fund) F. H. STOYE, Box 109, La Jolla, California; (Membership) MILTON B. TRAUTMAN, Stone Laboratory, Put-In-Bay, Ohio.

Treasurer—ARTHUR W. HENN, Carnegie Museum, Pittsburgh 13, Pennsylvania.

Secretary—EDWARD C. RANEY, Stimson Hall, Cornell University, Ithaca, N.Y.

Asst. Secretary—LOREN P. WOODS, U. S. National Museum, Washington, D.C.

Editors—Editor-in-Chief, HELEN T. GAIGE, 1211 Ferdon Road, Ann Arbor, Michigan; Ichthyological Editor, GERALD P. COOPER, Institute for Fisheries Research, Ann Arbor, Michigan; Herpetological Editor, KARL P. SCHMIDT, Chicago Natural History Museum, Chicago 5, Illinois.

Editorial Board—REEVE M. BAILEY, E. R. DUNN, NORMAN HARTWEG, RAYMOND E. JOHNSON, ROBERT R. MILLER.

Historian—WALTER L. NECKER, 6843 Hobart Avenue, Chicago 31, Illinois.

Officers of Western Division

President—W. I. FOLLETT, California Academy of Sciences, Golden Gate Park, San Francisco, California.

Vice-President—ROSS HARDY, Weber College, Ogden, Utah.

Secretary-Treasurer—FRANCES N. CLARK, California State Fisheries Laboratory, Terminal Island, California.

Honorary Foreign Members

F. ANGEL; L. F. DE BEAUFORT; LEO S. BERG; L. D. BRONGERSMA; FERNANDO DE BUEN; PAUL CHABANAUD; GEORG DUNCKER; S. L. HORA; C. C. LIU; NICÉFORO MARIA; ROBERT MERTENS; H. W. PARKER; P. J. SCHMIDT; J. L. B. SMITH; MALCOLM A. SMITH; A. VEDEL TÅNING; F. WALL; DAVID M. S. WATSON; G. F. DE WITTE.

Back numbers of COPEIA, as available, may be procured from Mr. M. Graham Netting, Carnegie Museum, Pittsburgh 13, Pennsylvania. Prices will be furnished on application.

Subscription, $5.00 per annum, $1.00 a copy.

Dues to Society, $4.00 per annum, including subscription to COPEIA.

Life Membership, $100.00, payable in one sum or four annual payments.

Dues and subscriptions are payable to the Society, through the Secretary.

Members should notify the Secretary immediately of any change in address.

Manuscripts, news items, and all correspondence regarding the Journal, should be addressed to one of the Editors.

Manuscripts should be submitted on good paper, as original typewritten copy, double-spaced, carefully corrected. Galley proof will be furnished authors.

Original contributions, not to be published elsewhere, are alone acceptable.

Reprints are furnished at approximate cost.

Figures, author's corrections, expensive tabular matter and unusually long articles may be charged in whole or in part to the author, at the discretion of the Editors.

ΙΧΘΥΣ
ΒΑΤΡΑΧΟΣ
ΕΡΠΕΤΟΝ